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Power Generation

May 1949

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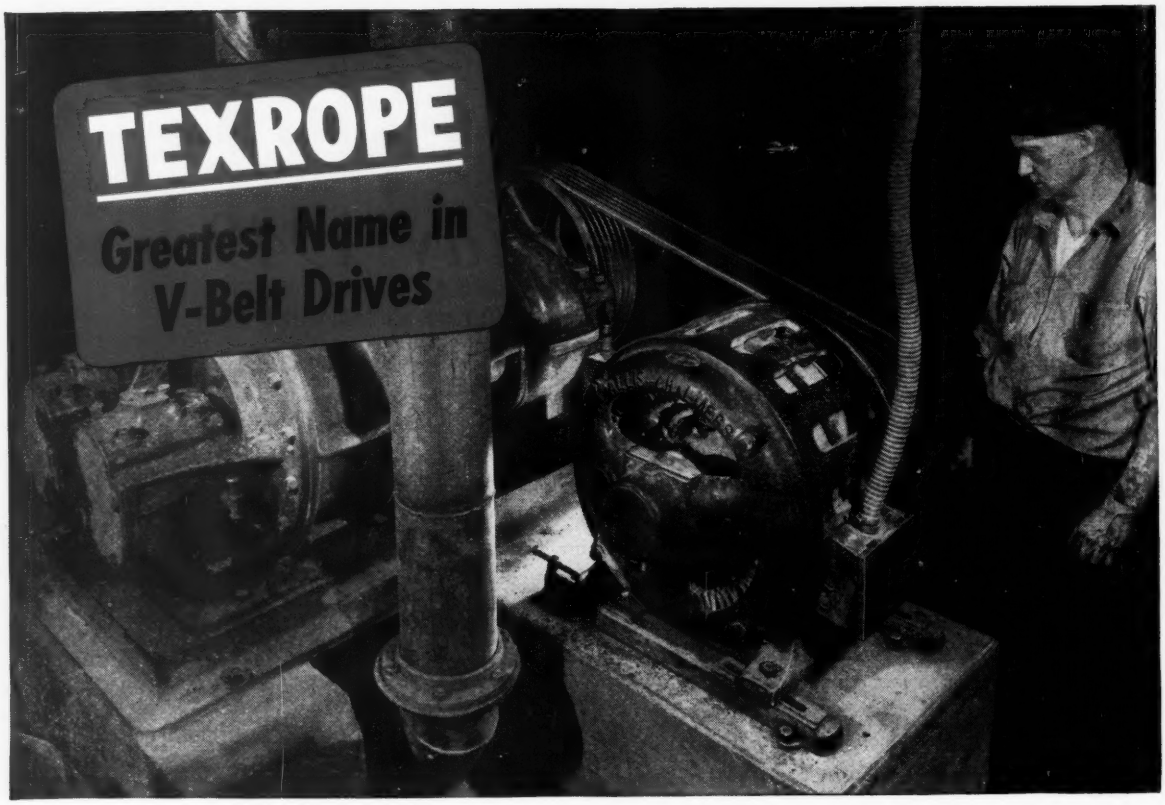

"No Upkeep Now"

BELT SLIP ELIMINATED, BEARING DAMAGE STOPPED, POWER WASTE ENDED WHEN *TEXROPE* V-BELT DRIVE REPLACES FLAT BELT.

CHIEF PLANT ENGINEER in this midwest plant says, "The old flat belt on this blower drive was twelve inches wide on twenty foot centers. Not only was it heavy but it also absorbed a lot of power.

"Besides that, dust made the belt slip constantly. We had to keep the belt so tight that it ruined bearings. And slipping would burn the belt. Maintenance on our old flat belt drive cost us hundreds of dollars every year.

"Four years ago an Allis-Chalmers representative recommended this *Texrope* drive. It doesn't slip at all, doesn't hurt the bearings and we haven't spent a cent on it. I wish we had changed to a *Texrope* drive years sooner."

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ENGINEERS' PREVIEW

FIRST COMPREHENSIVE study of registration of professional engineers has recently been made by Dr. A. M. Sargent. In a carefully documented and thoughtful analysis, Dr. Sargent points out that it is his purpose to examine the public necessity for the various engineering registration laws, call attention to the effects that strict enforcement would have on the industry and society in general, discuss the general requirements of the laws and point out some of the potentially dangerous practices open to administrative officials who are granted broad and vaguely defined powers. He reviews the way in which registration of engineers began, compares it with the licensing of other professions, raises and discusses the question "Can professional status be obtained by legislation?"

The next section is of particular interest in the Middle West because it deals with the Illinois court's attack on vital points of registration laws, and engineers in the Middle West have recently been closely in touch with the experience of the State of Illinois in obtaining passage of such laws. The decision of the Illinois court on these laws covers so well the most important phases of licensing legislation that Dr. Sargent quotes them in great detail. The rest of the book discusses such things as: who is a professional engineer; engineers who should not be licensed; how licensing can effect individual engineers; examination and experience requirements; and administration of registration laws.

In our opinion, Dr. Sargent has done a fine piece of work and has analyzed the entire registration situation about as objectively as it can be done. He ends by presenting a number of definite conclusions, points out good features and bad ones of the existing laws and suggests remedies and revisions to eliminate injustices and inequities that have arisen or might arise out of present legislation.

Dr. Sargent is himself a registered professional engineer, a past president of the American Society of Tool engineers and president and general manager of the Pioneer Engineering & Manufacturing Co. He has obviously studied the subject closely for many years. Copies of his booklet may be obtained for 75 cents each with special prices for copies in quantities of 10 or more. If you are interested in obtaining a copy, the EP editor will tell you how to do it, but please DO NOT send him any money, for he has no copies for sale.

★ ★ ★

RADICAL NEW PROCESS improvements now under development in the synthetic liquid fuels laboratories of the Bureau of Mines at Bruceton, Pa., offer promise of advancing the day when the United States can shift a part of the growing burden of oil and gasoline to its immense coal reserves.

Disclosing some of the achievements of this research in an address at Pittsburgh, acknowledging the Pittsburgh Award of the American Chemical Society, Dr. H. H. Storch, chief of the Bureau's laboratories at Bruceton, said that the objective is to assist in the development of a synthetic fuel industry in this country.

Coal to oil research activities are centered, he said, on fundamental improvements in the gas synthesis or Fischer-Tropsch process and on a basically new approach to the direct hydrogenation or Bergius-I. G. Farben process. (See *Power Generation*, January, 1948, page 64)

NUMBER ONE national problem, according to James W. Follin, Assistant Administrator of the Federal Works Agency, is control and abatement of water pollution. Before the annual ASCE Meeting he discussed federal aid plans for construction of sewage installation works estimated to cost between three and five billion dollars. This is a co-operative program and does not mean that the Federal Government has decided to shoulder the basic responsibility.

Another important discussion covered harbor and channel maintenance, which cost American taxpayers one-third as much in the last seven years as was spent in this work in the preceding century. Joseph M. Caldwell, Chief, Laboratory Section, Engineering and Research Branch, of the War Department's Beach Erosion Board, covered these activities in detail before the ASCE. Commercial activity of the harbors of a maritime nation is generally a fairly reliable index of the economic health of the nation, said Mr. Caldwell. Any natural phenomena which serve to restrict the normal development of the harbors of a nation, tend to restrain its economic advance.

Sedimentation is probably the dominant natural force tending to restrict the development of our harbors. Mr. Caldwell gave details of the battle engineers have been waging against these natural forces. Maintenance work, he said, has entailed removal of an average of 185 million cubic yards each year for the past seven years. Studies are needed to develop ways of decreasing rate of shoaling and increasing dredging efficiency.

★ ★ ★

STEADILY-INCREASING demand for engineering specialists is foreseen by American industry. It expects the colleges to continue to supply engineers of increasingly broader competence. It is willing, for the most part, to help meet the increased costs which such a program of education puts upon the colleges of engineering. These are the salient views expressed by 550 representative industrialists in an analysis recently made public by Rensselaer Polytechnic Institute.

Highlights of the study are: 1. Although industrial production is at highest peace-time level in the nation's history, 76 out of each 100 of the executives think that the demand for engineering specialists will continue to increase during the next ten years. The remainder see no slackening in the need. 2. Of each 100 of the industrialists, 78 say the colleges should raise the level of faculty salaries as a major step in supplying engineers of broader competence. (Editor's Note: The ideal situation would be to have teaching and industrial salaries on such a basis that an individual engineer would choose a teaching or industrial career, or perhaps a combination of both, according to his interests, temperament and training, and could move back and forth between the two with no loss of prestige. The effect of this on the quality of engineering teaching might be very startling.) 3. Sixty-five of each 100 think that industry and business, in one way or another, should help the colleges of engineering carry the heavily increasing burden of costs, which this progressive program entails.

Since the state of engineering education and that of the engineering profession are intimately entwined, this analysis of opinion should prove of great interest and benefit not only to the colleges but to everyone concerned with the industrial economy. For complete copies of the survey and its results, write the EP Editor.

FACTS WITH A PUNCH, and how you find them if you just keep punching, is a story recently told in *Progress thru Research* and should interest all engineers. As engineers know, if you should ask the Army and Navy how many men with blue eyes and brown hair helped to win World War II, they could give you the answer in a few seconds by the use of the records on punched cards. Engineers are interested in anything that will help them cope with the overwhelming flood of technical literature, as we have pointed out many times in these columns, and a very interesting method for doing it with a punch has been worked out by A. Furman Isbell, chemist in the General Mills' Organic Research Section.

Like many other engineers and scientists, he had trouble in keeping track of reference material. He'd read a scientific article, write out a card listing the subject matter of the paper and drop it in his file, but when he tried to pull it out a few months later, it usually had moved—doesn't that sound familiar? He developed a set of 5-by-8-in. cards each with 29 numbered holes across the long edges at top and bottom. The numbers of these holes correspond to code numbers assigned to various subject classifications. Other holes on the narrow edges indicate whether or not the article describes a patent, gives its general type and its year of publication.

To use the system, Mr. Isbell simply sits down with whatever article he wants to read, along with one of these cards and a V-shaped punch. On the card he writes title, author and other data on the article. When he runs across some bit of information worthy of future reference, he punches out on the edge of the card three numbers assigned to that broad subject and then fourth and fifth numbers assigned to a sub-division under the subject. Then he files the cards in any order whatever.

In order to pick out all material on a given subject, he picks up the entire card file and inserts a long pointed instrument, much like an ice pick, through the hole labeled with the code number of the first general classification he is looking for. Now cards on which that number have been punched out with the V-shaped punch have no support, so they fall out of the file, while the others remain suspended from the ice pick. He then discards those that did NOT fall and repeats the process; and finally he gets all the cards of a certain classification he is looking for.

Mr. Isbell has used his punch card system since December 1947, says he hasn't found a major flaw in it.

★ ★ ★

MANY YOUNG MEN are now preparing for the engineering profession, therefore the Engineers' Council for Professional Development has adopted Canons of Ethics for Engineers, especially to serve as a guide to these young engineers as they progressively assume professional responsibility. These Canons were published in full in the March 1948 issue of ***Power Generation.*** They supplement the engineering tradition of honest public service and the example of professional leaders.

The ECPD is now making available copies of the Canons of Ethics attractively printed on 9¼x14 in. cards for framing, and in the standard 8½x11 in. size for general distribution. The large size is in two colors and sells for 50 cents per copy, the smaller size for 10 cents per copy or 5 cents when purchased in bulk. Copies may be obtained through the Engineers' Council for Professional Development, 29 West 39th Street, New York 18, N. Y.

IT WOULD BE a good thing to have a kind of revolution in our economic thinking, Sumner H. Slichter, noted Harvard economist, and chairman, Research Advisory Board, Committee for Economic Development, told the trustees of that organization recently.

"CED has long been attempting," Dr. Slichter said, "to bring this about, and to some extent it has succeeded. But even among businessmen, after CED has been in existence for six or seven years, one finds a great fear about the adequacy of demand: will there be enough market?

"The great danger, as I see it, is that businessmen will set their sights too low. If you look at what has happened in the United States since the beginning, the most typical thing, the most usual thing that the economy has done, has been to expand.

"One of the greatest blunders of economists is that they have made economics a study of the conditions of equilibrium instead of a study of the conditions of expansion. Only about one-fifth of the time has the economy been contracting; four-fifths of the time it has been expanding.

"It expands because of the insatiable demands for goods, and that takes the form of people spending more than their income."

If the pressure for goods continues as great as it has been, Dr. Slichter said, it can be translated into higher real earnings only by output per man hour rising about four times as fast as it has in the past.

★ ★ ★

MINING FOR OIL by the open-cut method, instead of drilling wells, is being carried out in San Luis Obispo County, California, according to the Bureau of Mines. Oil occurs in bitumen in sandstone and can be separated by treatment with alkaline hot water, yielding 26 gallons of oil a ton, plus asphalt and coke. The deposit being studied contains a quarter of a billion tons of the bituminous sandstone.

★ ★ ★

BRAIN-TEASER:—The "inverted check" problem. We have been snowed under with solutions to this problem ever since Dr. Smith's answer was published in the February ***Engineers' Preview***—snowed under to the extent that, for purely mechanical reasons, we just cannot publish any more of the answers, unless readers want to see page after page of them.

But it happens that most of them fall into one or another of the patterns of solution given in the April issue, with variations here and there. Anyway, our heartiest thanks for your interest in sending them in. It was great fun while it lasted. We especially want to thank: Joseph Baumann (Foster Wheeler Corp.); N. W. Richards (American Gas & Electric Service Corp.); Robert Lake (Jackson, Mich.); Martin Lovaas (International Paper Co.); Frank U. Neat (Consolidated G., E. L. & P. Co. of Baltimore); Carroll H. Easler (Oak Ridge, Tenn.) and C. F. Liddell (London, England) for their cogent comments, in addition to those published.

We considered establishing a brain teaser department, but that might mean starting a separate magazine for it. Here's why. One b.t. leads to another. Joseph Baumann, with his "inverted check" answer, sent in another one about four pirates and a pile of gold coins.

Stop us if you've heard it. But if you haven't, ask the E. P. Editor for a copy of it and take a crack at it. We might even take the risk of publishing it—but we'll get snowed under again if we do so.

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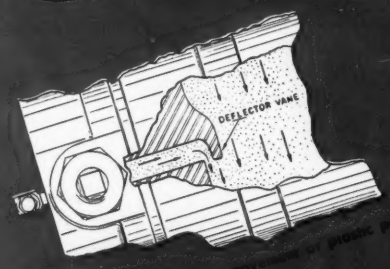
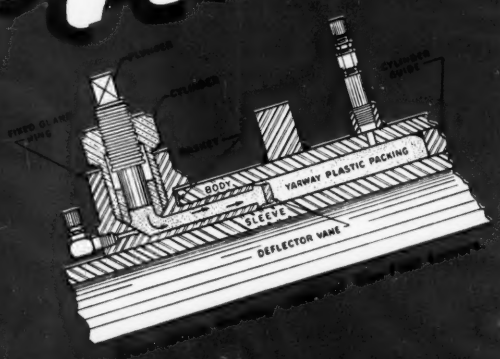
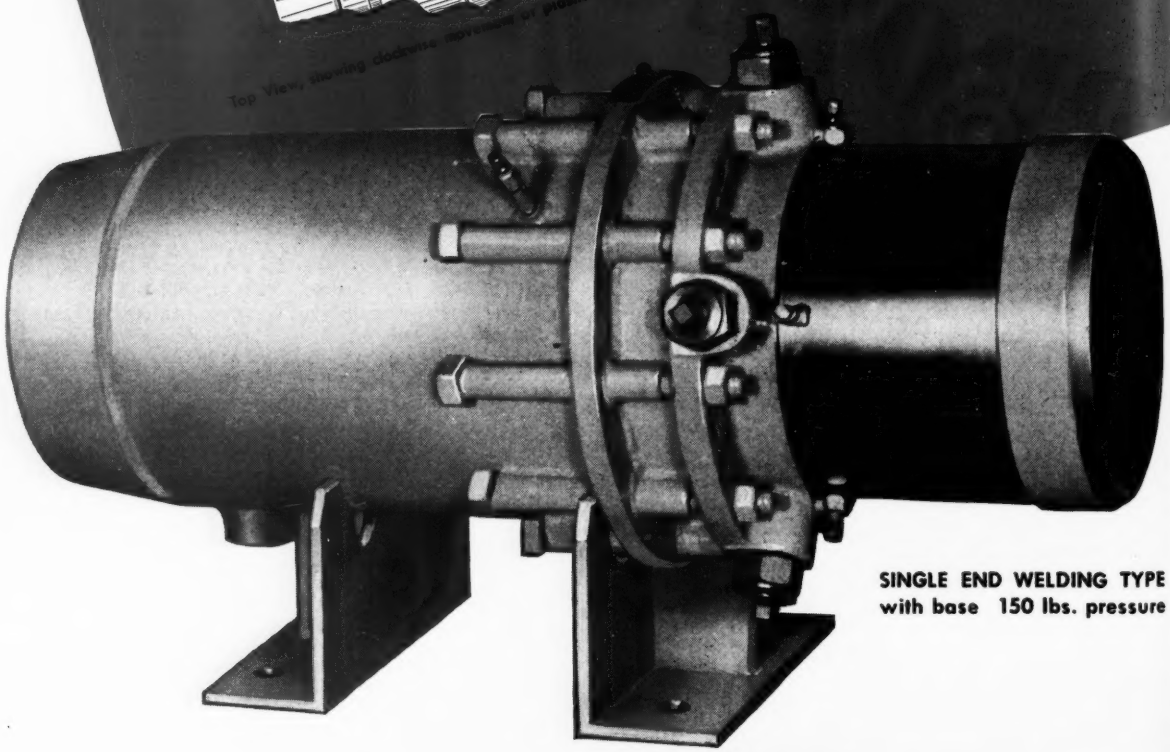




Top View, showing clockwise movement of plastic packing.



SINGLE END WELDING TYPE
with base 150 lbs. pressure

YARWAY

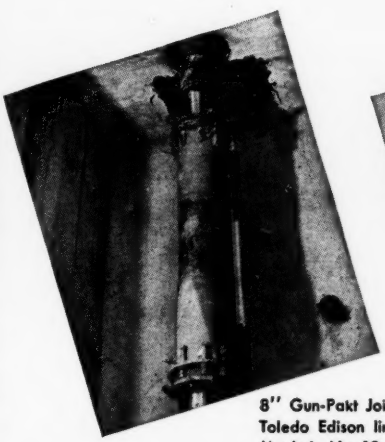
TOLEDO EDISON CHOOSES THE EXPANSION JOINT THAT IS *Serviced* UNDER FULL STEAM PRESSURE

Toledo Edison Company knows how to save on expansion joint maintenance. They use Yarway GUN-PAKT Joints—22 of them, ranging in size from 8″ to 14″ on their recent steam distribution extension.

GUN-PAKT Joints are serviced under full steam pressure . . . no costly shutdowns or heating interruptions. For repacking, simply insert a packing plug, twist a wrench, and the job's done! Special Alemite fittings provide for proper lubrication. Maintenance costs are low. One user says only 65 cents per year per joint. Others claim less than that. But wherever steam is distributed, and expansion joints are used, the trend is toward GUN-PAKT.

Read the GUN-PAKT story in Yarway's Bulletin EJ-1912. Write—

YARNALL-WARING COMPANY
114 Mermaid Ave., Philadelphia 18, Pa.



8″ Gun-Pakt Joint on Toledo Edison line at Manhole No. 12.

Yarway Gun-Pakt Joint on Toledo Edison Jackson Avenue line.

14″ Gun-Pakt Joint in Toledo Edison No. 1 Manhole.

Answering a reader's question on smoke and soot conditions, the BERGEN ENGINEER, official organ of the Bergen County Chapter (New Jersey) of the N.A.P.E., replied

> "... *Any stoker will burn any kind of coal after a fashion, but only coal of definite characteristics* EFFICIENTLY ..."

The coals that are available to *you* are the coals you are interested in. The stoker that will burn *those* coals efficiently is your natural requirement. And Combustion supplies that need with the most complete line of stokers available *anywhere*. Here you are free to choose, from all basic types, the stoker that exactly fits your three-way problem of fuel characteristics, load and operating conditions. No need to settle for a compromise that will burn your coal "after a fashion".

Getting the *right* stoker is more important than ever today as coal costs rise, for the cost of fuel burned soon far outweighs the original equipment cost. Careful selection of stokers means dividends in dollars as well as operating satisfaction. Let our engineers help you in this choice. More than 20,000 C-E stokers, serving all industries and burning every type of coal, provide an impressive background of experience. And Combustion's *complete* line assures you an unbiased recommendation ... the experienced judgment of a manufacturer that has no axe to grind.

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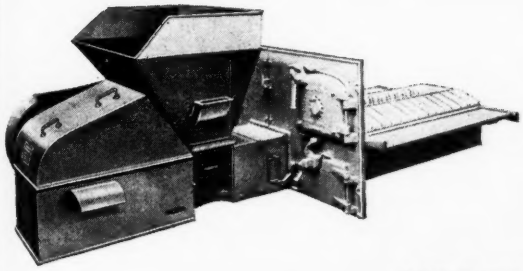
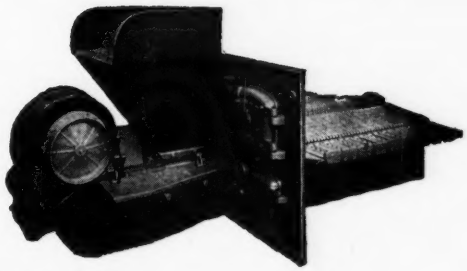
A MERGER OF COMBUSTION ENGINEERING COMPANY, INC. AND THE SUPERHEATER COMPANY

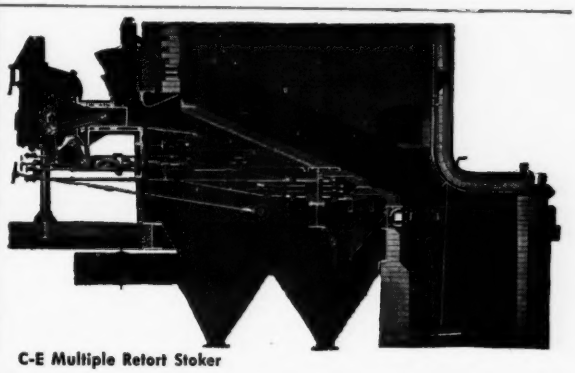


C-E Skelly Stoker

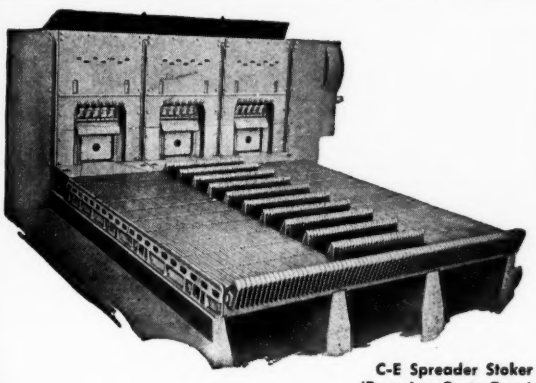


C-E Low Ram Stoker

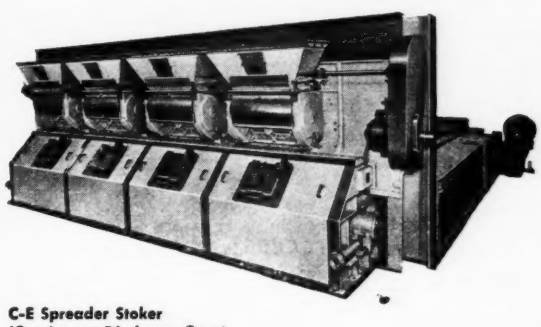
C-E Type E Stoker



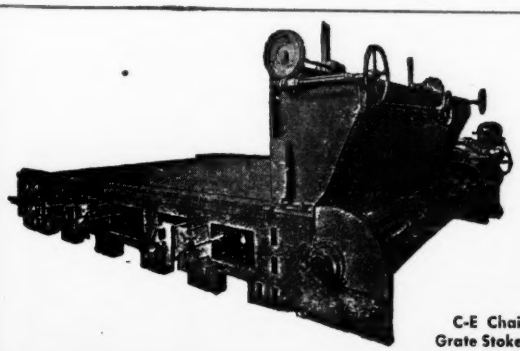
C-E Multiple Retort Stoker



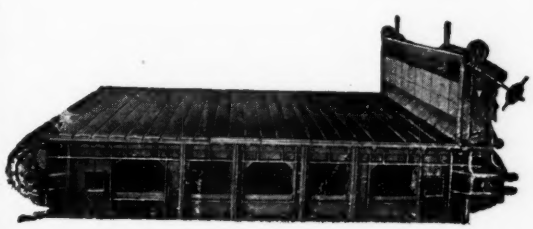
C-E Spreader Stoker
(Dumping Grate Type)



C-E Spreader Stoker
(Continuous Discharge Type)



C-E Chain
Grate Stoker



C-E Traveling Grate Stoker

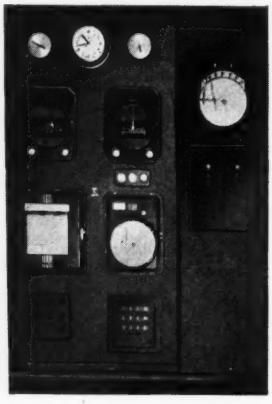
C-E—SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

WATER CONDITIONING EXPERIENCE PROVES ITSELF

The fact that users of Cochrane water conditioning apparatus continue to come back to Cochrane for additional equipment when plants are expanded or new ones established is adequate proof of the consistently satisfactory operation of Cochrane softeners, deaerators, filters, etc.

Pittsburgh Plate Glass Company is one of Cochrane's old customers who have ordered and reordered Cochrane softeners year after year, some of these orders going back over thirty years.



The Cochrane Hot Process Softener installation at Pittsburgh's Columbia Chemical Plant at New Martinsville, W. Va., shown on these pages, was originally installed as a simple lime-soda softener to treat 40,000 GPH of Ohio River water having a calcium carbonate hardness of 40 ppm. The treated water is deaerated in the Cochrane Atomizing Deaerator section. The sedimentation tank also includes a separate tray type condensate deaerator having a capacity of 50,000 GPH.

Recently, because of the long retention time resulting from excess capacity, the softener has been used as a two-stage system by adding phosphate to the uptake funnel of the sedimentation tank.

Controls are located conveniently on a panel board where adjustment of chemicals may easily be made by means of the Cochrane electrically operated proportioner.

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Philadelphia 32, Pa.

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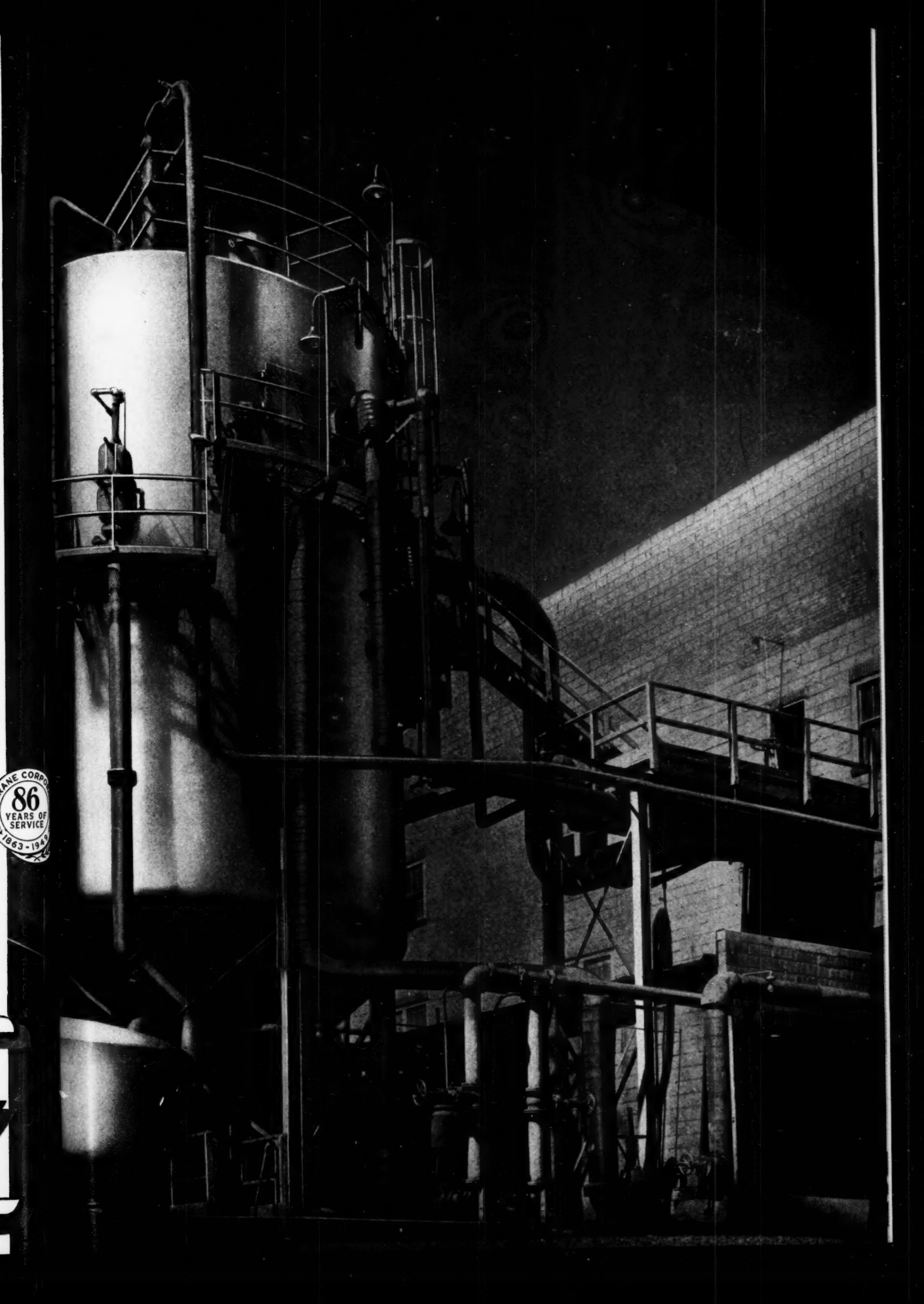
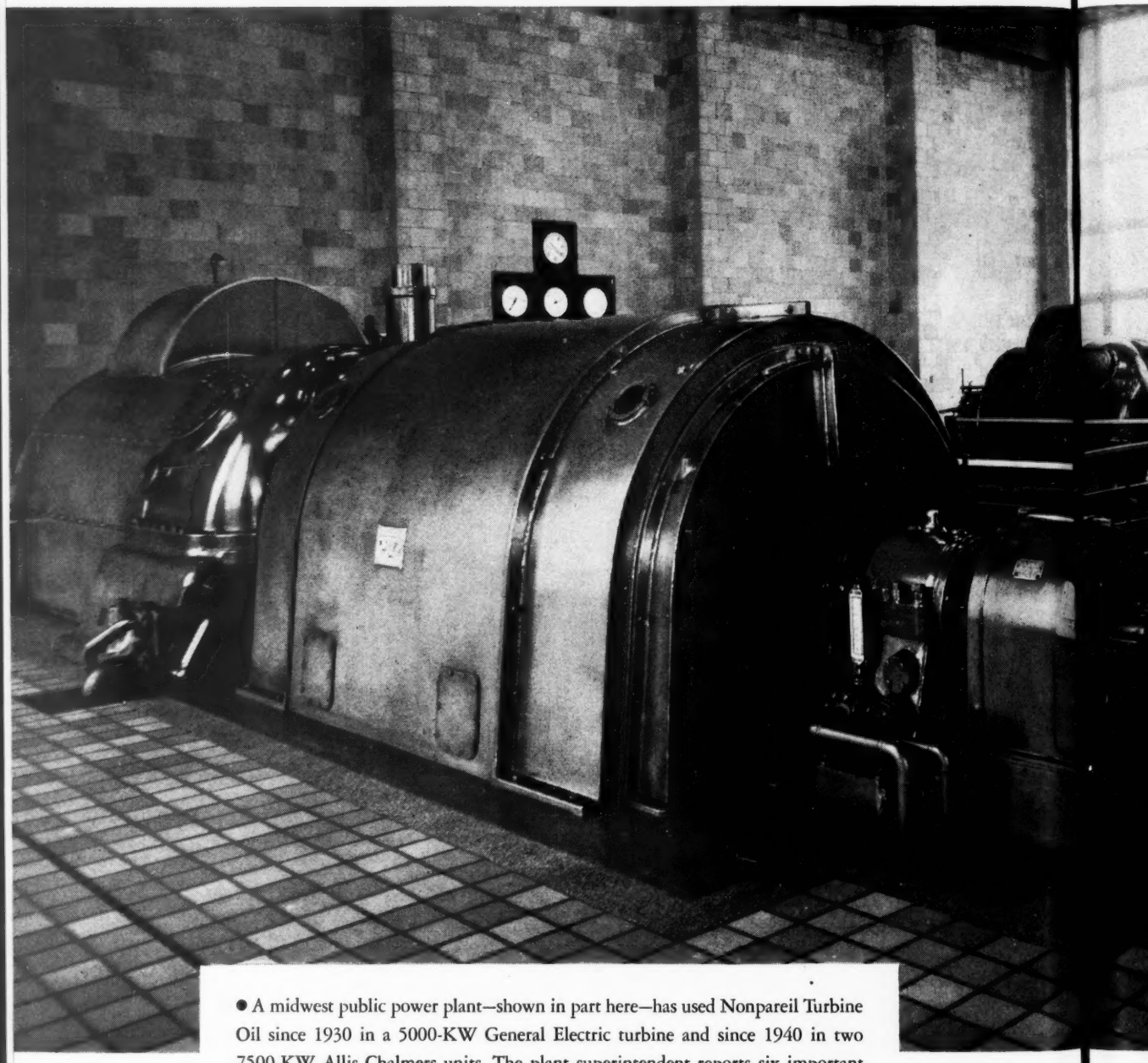

86
YEARS OF
SERVICE
1863 - 1949

Save 6 ways on...t



● A midwest public power plant—shown in part here—has used Nonpareil Turbine Oil since 1930 in a 5000-KW General Electric turbine and since 1940 in two 7500-KW Allis Chalmers units. The plant superintendent reports six important savings made with Nonpareil.

STANDARD

STANDARD OIL COMPANY (INDIANA) ST

...turbine lubrication

NONPAREIL
Turbine Oil
"Will outlast your turbine"

Nineteen years' service by Nonpareil Turbine Oil has given ample evidence of Nonpareil's great saving ability in a midwest public power plant. The superintendent reports:

1. **No oil-replacement fills**
2. **No extra oil batches**
3. **No sweetening of oil**
4. **No oil-treating losses**
5. **No cleaning of oil systems**
6. **No repairs due to faulty lubrication**

In addition, the superintendent states that the quantity of make-up oil has been held very low—less than an average of 12 gallons per year needed for 3 turbines.

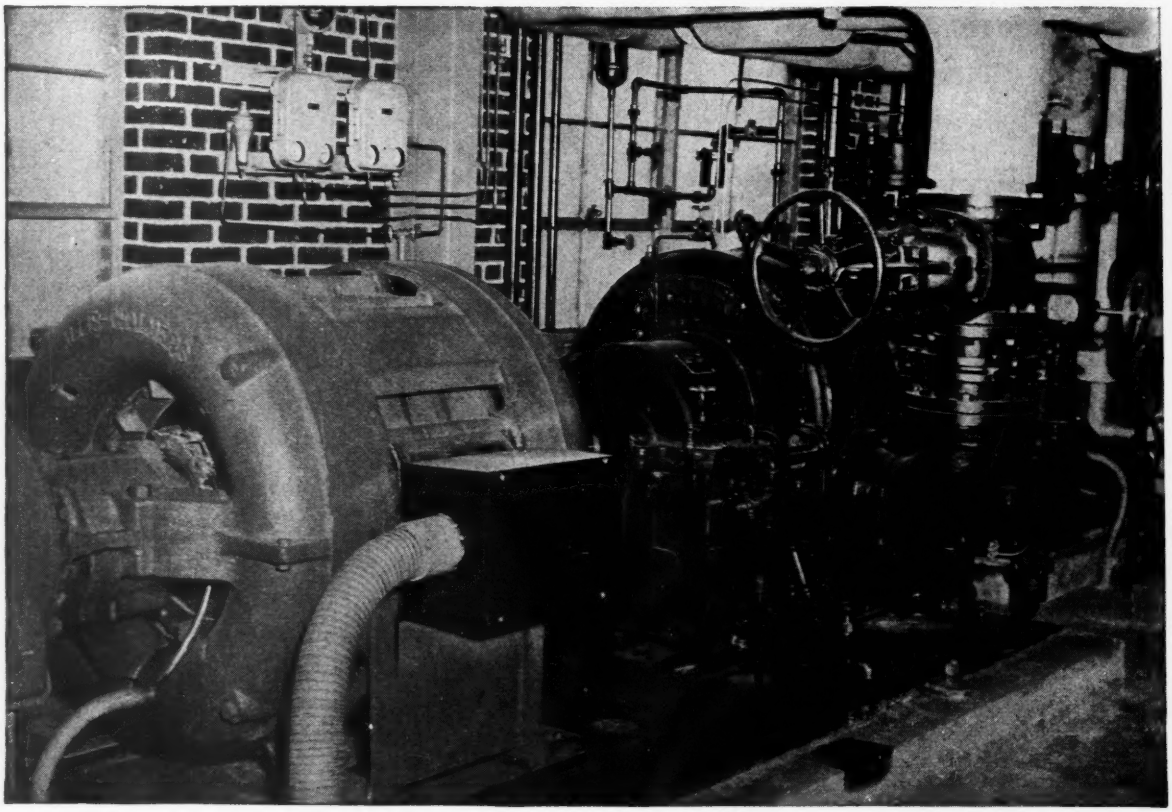
Why not take advantage of Nonpareil's great saving ability? This unique turbine oil can reduce oil maintenance and lubrication troubles to a rock-bottom low in your plant. Its ability to do this is backed by a written guarantee.

Nonpareil is the only turbine oil that is guaranteed in writing not to increase in acidity above a neutralization number of 0.15 mg. KOH/gm. That is your insurance against troubles, your assurance of lubrication savings. A Standard Oil Lubrication Engineer will be glad to give you facts and figures from other Nonpareil performance records.

Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago 80, Ill.

NA) STANDARD OIL COMPANY (INDIANA) STANDARD

The TERRY TURBINE



For By-Product Power and Steam Balance

This 200 kw Terry Turbine driven generating unit operates in parallel with other generating equipment, the load on the unit being adjusted in accordance with the demands for exhaust steam. It is a single stage axial-flow, type, 4500/1200 rpm, 160 psi, 0 superheat, 5 psi back pressure, equipped with Terry reduction gears, oil-relay governor, motor synchronizer and back-pressure regulator.

The installation pictured above is typical of many special applications of Terry Steam Turbines, each designed for specific requirements.

Any of our district representatives will gladly give you full information on a turbine to meet your requirements, no matter how special they may be.

No obligation, of course.

T-1176

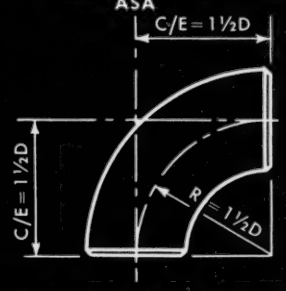
THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Improvements and economies in welded piping result from this *Variety* of

MIDWEST ELBOWS

1

LONG RADIUS ASA

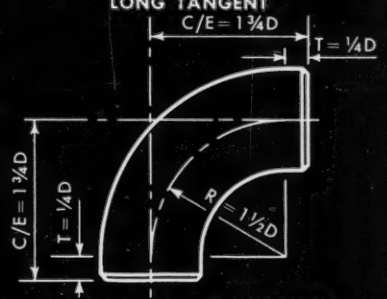


SIZES: ¾" TO 24", INCLUSIVE

Dimensions conform to applicable size range of American Standard for Butt-Welding Fittings, ASA B16.9. Radius and center-to-end dimension equal 1½ times nominal pipe size.

2

LONG RADIUS LONG TANGENT

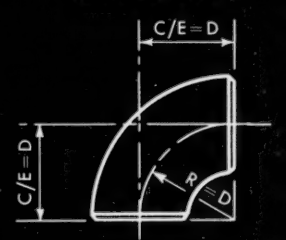


SIZES: 2" TO 20", INCLUSIVE

Same radius as ASA Elbows but with long integral tangent on each end — an exclusive Midwest feature that saves time and pipe. No price increase over ASA Elbows.

3

SHORT RADIUS

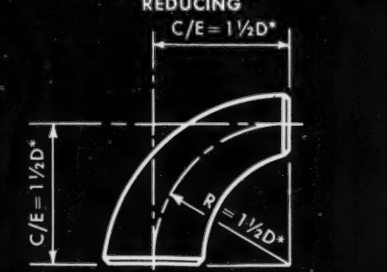


SIZES: 1" TO 30", INCLUSIVE

Where space limitations prevent use of ASA Elbows or Midwest "Long Tangent" Elbows shown above at right, these short turn elbows without tangents are recommended.

4

LONG RADIUS REDUCING



SIZES: 2" TO 12"*, INCLUSIVE

Midwest Reducing Elbow takes the place of a straight elbow and a reducer. It saves more than one-third of the welding and improves both design and appearance.

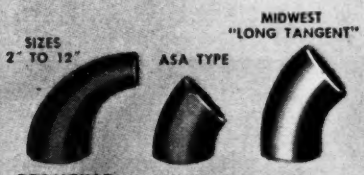
SYMBOLS { *C/E—Center-to-End Dimension* *T—Length of Tangent*

D—Nominal Pipe Size *R—Radius* **D—Dimension is for larger Pipe Size*

MIDWEST WELDING FITTINGS

Improve Piping Designs and Reduce Costs

90° ELBOWS



REDUCING 90° ELBOWS

45° ELBOWS

LAP-JOINT STUB ENDS

REDUCERS

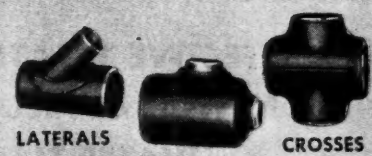
CAPS

SADDLES

SLEEVES

RETURN BENDS

TEES



LATERALS

CROSSES

REDUCING-ON-RUN TEES

SHAPED NIPPLES

FLANGES

The *variety* of Midwest Welding Elbows is particularly important because of the exceptional latitude in design and economy in erection that it provides. For example, the Midwest Long Tangent Elbow permits faster, easier, more accurate lining up with pipe . . . removes weld from point of maximum bending stress . . . often eliminates a short nipple and its extra weld. Slip-on flanges are easily used with minimum change in flange and fitting.

This "Variety" is only one of several reasons why many users prefer Midwest Welding Elbows.

Only MIDWEST offers this VARIETY

MIDWEST PIPING & SUPPLY CO., Inc.

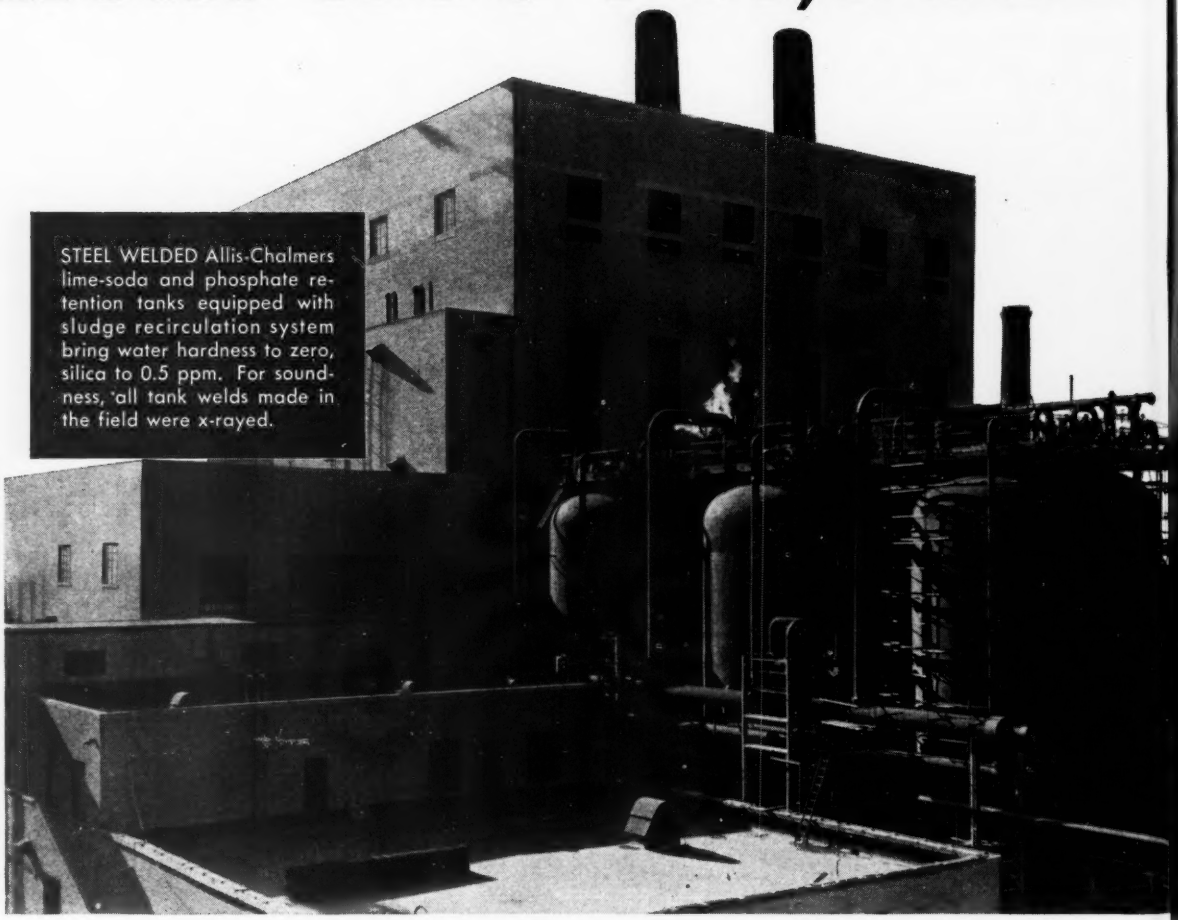
Main Offices: 1450 South Second Street, St. Louis (4), Mo.

***Sales Offices:* New York (7), 30 Church St.**

Chicago (3), 79 West Monroe St. • Los Angeles (33), 520 Anderson St. • Houston (2), 229 Shell Bldg. • Tulsa (3), 533 Mayo Bldg. South Boston (27), 426 First St. • Distributors in Principal Cities.

RECORD WATER CONDITIONING

Runs 1350 PSI, 900 F



STEEL WELDED Allis-Chalmers lime-soda and phosphate retention tanks equipped with sludge recirculation system bring water hardness to zero, silica to 0.5 ppm. For soundness, all tank welds made in the field were x-rayed.

EFFECTIVE TREATMENT PLUS CLOSE CONTROL OF CHEMICALS IN NEWLY DEVELOPED PROPORTIONING SYSTEM BRINGS RAW WATER HARDNESS TO ZERO, SILICA TO 0.5 PPM!

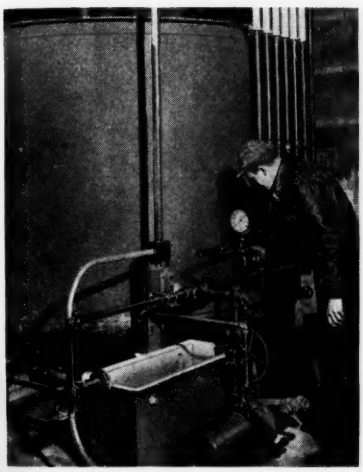
A HUGE TWO-STAGE HOT PROCESS lime-soda phosphate softening system recently installed at a Midwest refinery by Allis-Chalmers is making water conditioning history! Here, treated water is fed to three dual circulation boilers at the rate of 160,000 gph to generate steam for the production of by-product electric power.

In operation, chemical slurries of lime-soda and phosphate are released from mixing tanks through automatic chemical proportioners mounted on each tank. Several times a minute orifice type meters on the raw water line transmit impulses to these proportioners to secure chemical feed proportionate to flow of water.

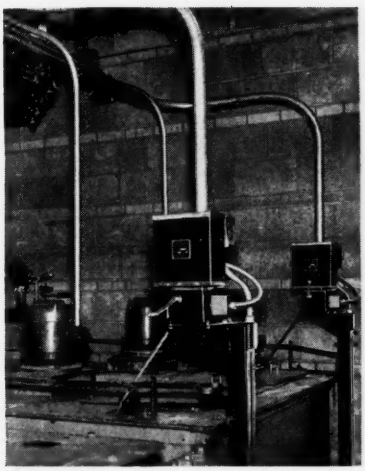
In the lime-soda retention tank hardness is first brought down to about 15 ppm and silica reduced to 0.5 ppm by sludge recirculation. In the secondary or phosphate stage, hardness is reduced to zero. Pressure filters clarify the final effluent.

Now on order, a third Allis-Chalmers extension will further increase treating facilities by raising the system capacity to 240,000 gph. With a total of six tanks, 24 filters, and including all other equipment, this new water conditioning system will undoubtedly be the largest ever to be placed in a refinery power plant!

INSTALLATION
Boilers on 100% Makeup

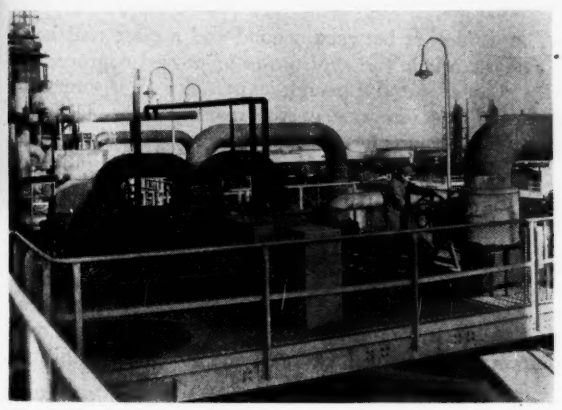


IN THE CHEMICAL treating building, welded steel feeder tanks mix individual slurries of lime-soda and phosphate which are automatically ratioed to incoming raw water by American Electro-Magnetic Proportioners.



PROPORTIONERS are solenoid operated. Extremely accurate clutch mechanism lowers swing pipe into chemical tank allowing slurry to enter pump suction tank. Allis-Chalmers pumps then carry the slurry to retention tanks.

CONTROL panel records all temperatures, pressures and flow rates. Amount of sludge blowdown as well as proportion of chemicals fed are regulated by simple calibrated dials. Overall completeness of control is truly outstanding.



PLATFORM CONNECTING new power plant with 60-ft high Allis-Chalmers retention tanks gives access to control valves, and permits inspection of vent condensers, vacuum breakers, four-speed mixers.

PLANT OPERATORS,
Check Allis-Chalmers 3-Way Program!

Whether your plant is large or small, Allis-Chalmers affords you the same dependable 3-way program of complete *service, chemicals* and *equipment* as it did this refinery. And remember, A-C not only provides a first hand study of your water treating needs, but works right along with you in selecting the correct process and equipment for your particular requirements.

SERVICE — complete analysis of water supplies; reports on water-steam cycle; study of present equipment; advice on selection of chemicals; periodic reports and service calls.

CHEMICALS — scale inhibitors for all heat exchange cycles. Special chemicals to prevent boiler scale, control corrosion, reduce silica, and correctly condition sludge.

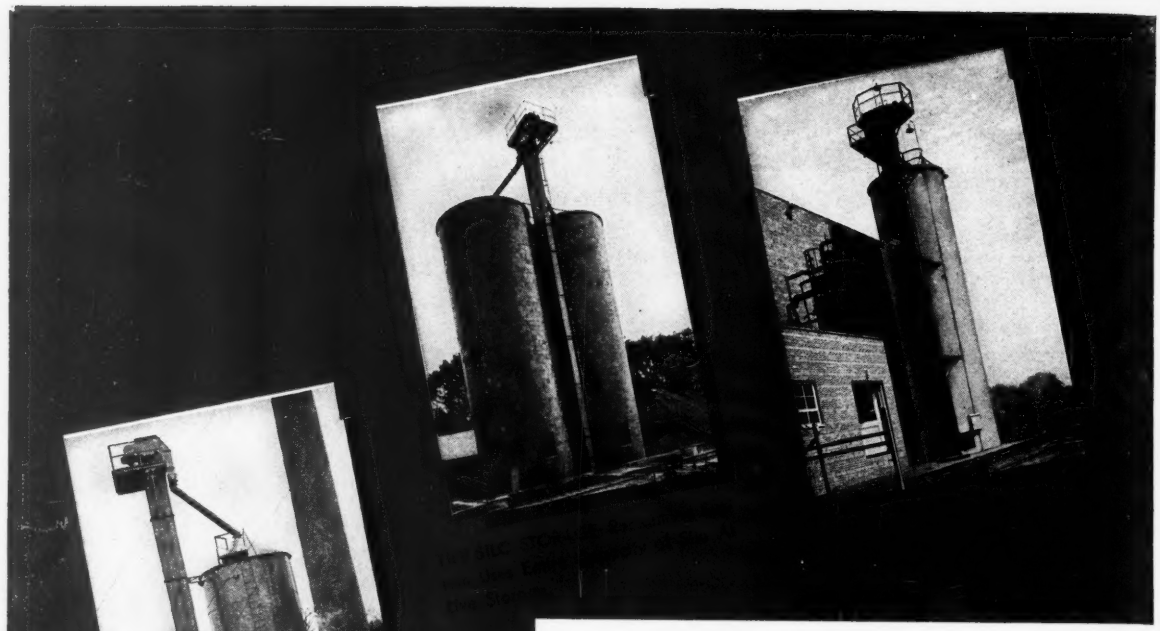
EQUIPMENT — hot and cold process softeners, sodium and hydrogen zeolite softeners, degasifiers, deionizers, chemical proportioners, oil removal and water filters. A 2693

ALLIS-CHALMERS, 953A SO. 70 ST.
MILWAUKEE, WIS.

A-C ALLIS-CHALMERS

ALLIS-CHALMERS

Water Conditioning Service . . . Chemicals . . . Equipment



your COAL STORAGE PROBLEM

Fits Into ONE of These Pictures...

Wherever you are located, whatever space you have available, however much capacity you need . . . one of these four basic types of G-W Coal Storage Systems should fit your requirements.

The difference between a good and a poor coal handling system is in the *application* of proved engineering principles acquired through experience plus common sense and the integrity of the manufacturer. Gifford-Wood has designed each of the four types shown on the basis of a definite application for geographical location, available space and initial cost per ton of available storage.

G-W *knows* how to meet such conditions, and applies 140 years' of experience to the design of coal handling and storage systems for steam generating plants. Then the *one* right system is fabricated and installed under *one* contract, *one* delivery schedule and *one* responsibility.

Gifford-Wood's engineering service is available to consultants, engineers and plant owners at no obligation. Get in touch with a G-W engineer today.

GIFFORD-WOOD CO.

G-W HANDLES IT...
faster • easier • cheaper

SINCE 1814
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NEW YORK 17
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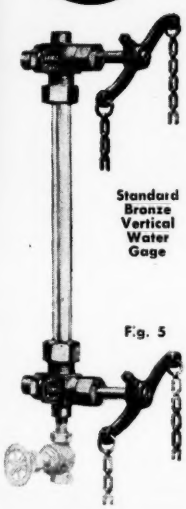
SPECIFY ERNST

GAGES

bronze forged steel all-iron

ALSO STAINLESS STEEL FOR ALL KINDS OF SERVICE



Standard Bronze Vertical Water Gage

Fig. 5

Fig. 1-G

Split-Gland water gage can be set Vertical or Inclined

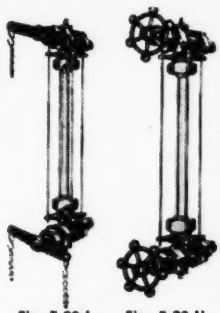


Fig. E-90-L Fig. E-90-H

Lever and Hand Wheel Type Forged Steel Gages

Water Columns high and low alarm

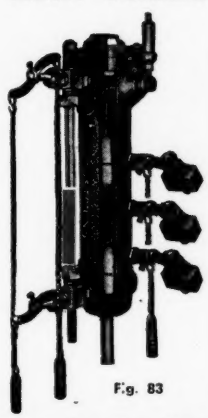


Fig. 83

High & Low Alarm Column with Vertical Gage and DCP Weighted Type Try Cocks

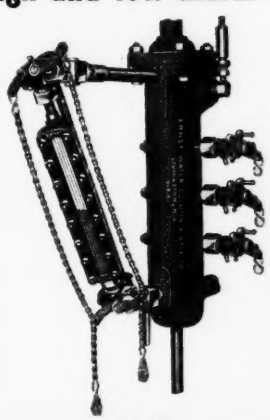
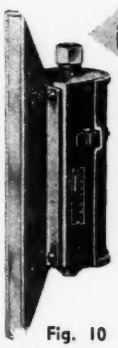


Fig. 32
Column Equipped with Inclined Prismatic Reflex Insert and Series 450 Try Cocks

SPECIAL WATER COLUMNS GAGES AND COCKS TO SPECIFICATIONS



illuminators

"PLAIN SIGHT" NON-GLARE

gage glass guards

PLASTIC NON-BREAKABLE

Fig. 10

Fig. 31

TRY COCKS

LEVER & WEIGHTED TYPE FOR ALL TYPES OF BOILERS

Fig. 13

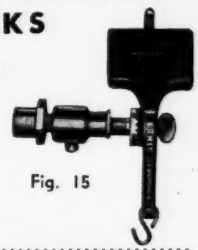


Fig. 15

SIGHT FLOW INDICATORS

for insertion into pipelines

Fig. E-57
Bulls Eye Type

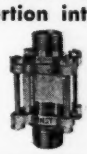


Fig. 17-28
Tubular Glass Type

Fig. E-811
Flapper Type

HIGH PRESSURE

GLASSES AND GAGE GLASS GASKETS MANUFACTURED IN ALL SIZES TO FIT YOUR WATER GAGES

Fig. 14

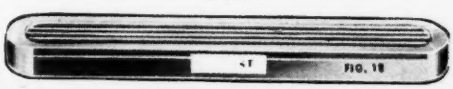


Fig. 22 Series 750, Std. Patt. Fig. 21 Lipmold Type

STATE YOUR REQUIREMENTS—Send for Catalog

Ernst Water Column & Gage Company

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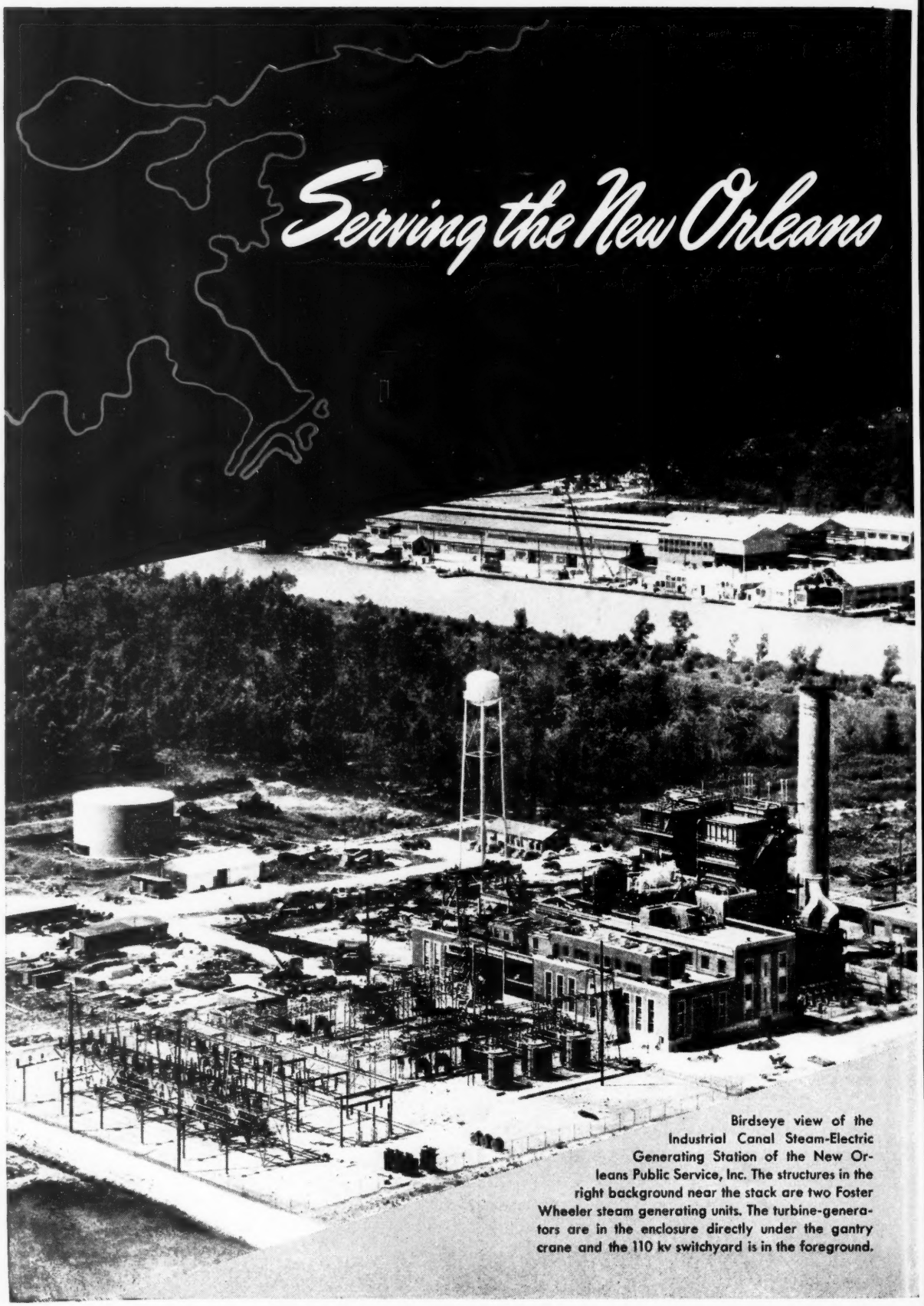
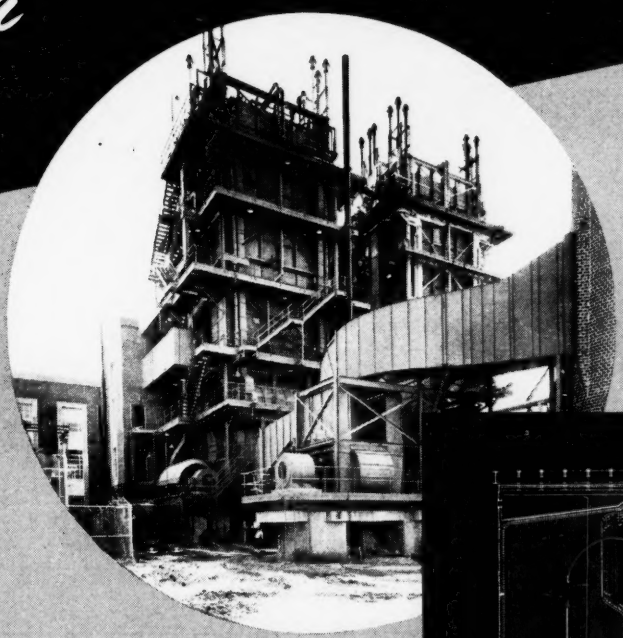
Serving the New Orleans



Birdseye view of the Industrial Canal Steam-Electric Generating Station of the New Orleans Public Service, Inc. The structures in the right background near the stack are two Foster Wheeler steam generating units. The turbine-generators are in the enclosure directly under the gantry crane and the 110 kv switchyard is in the foreground.

area

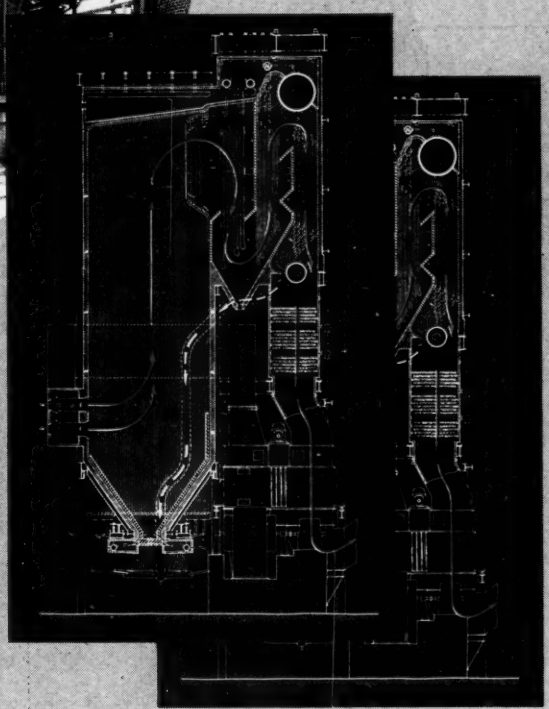


Two Outdoor Foster Wheeler Steam Generating Units for

Industrial Canal Steam-Electric Generating Station of

New Orleans Public Service, Inc.

Steam capacity per unit	400,000 lb per hr
Superheat control range	225,000 lb per hr to 400,000 lb per hr
Pressure superheater outlet	1,350 psi
Final steam temperature	955 F



The Industrial Canal Steam-Electric Generating Station of the New Orleans Public Service, Inc. is in consonance with the times which more than ever demand a sensible investment policy. This modern station combines lower investment cost of semi-outdoor construction with operating economies of a high pressure and high temperature steam cycle. Two 400,000 lb per hr FW steam generators, which are completely outdoors, serve two 37,500 kw turbines which are housed in individual semi-demountable enclosures directly under a single gantry crane.

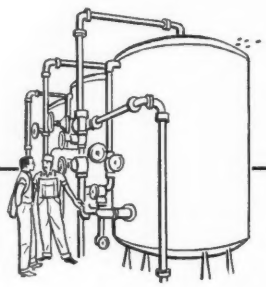
The steam generating units are designed for firing natural gas, oil, or future pulverized coal and are arranged for automatic condenser-type steam temperature control.

FOSTER WHEELER CORPORATION, 165 Broadway, New York 6, N. Y.

FOSTER WHEELER

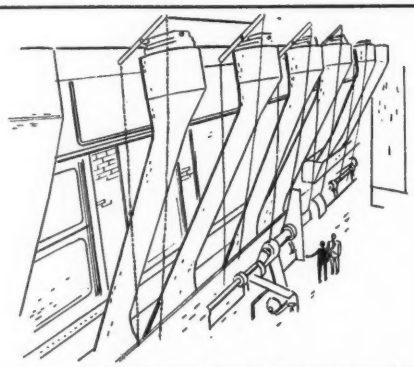
HERE IS THE Starting Point OF HALL BOILER WATER CONDITIONING

When Hall Laboratories recommends procedures for Boiler Water Conditioning, these procedures are "tailored" to fit *your* plant. Hall service starts, therefore with a study of your plant, considering especially (1) raw water supply, (2) facilities and requirements for pre-treatment of water, (3) steam generating equipment, and (4) steam uses.

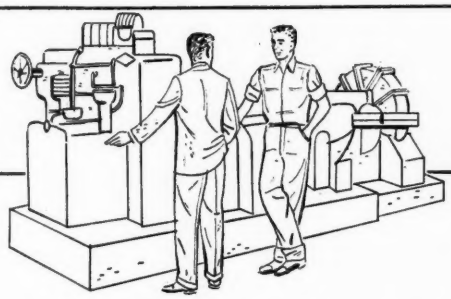


Softening and other forms of raw water pre-treatment are often desirable and sometimes absolutely necessary. Hall considers these from the point of view of results and costs *in your specific case*, and helps you to get best results from equipment you already have.

The treatment needed to give you the kind of water you *want* depends first of all on the kind of water you *have*, so samples of water from all sources available to you are carefully analyzed in our Pittsburgh laboratories.



Thorough knowledge of your boilers and of pre-boiler equipment is essential in setting up a program of boiler water treatment. Type of boiler, pressure, capacity, kind of firing, nature and extent of load variations, and dozens of other facts must be considered, as all of them have a bearing on boiler water treatment.



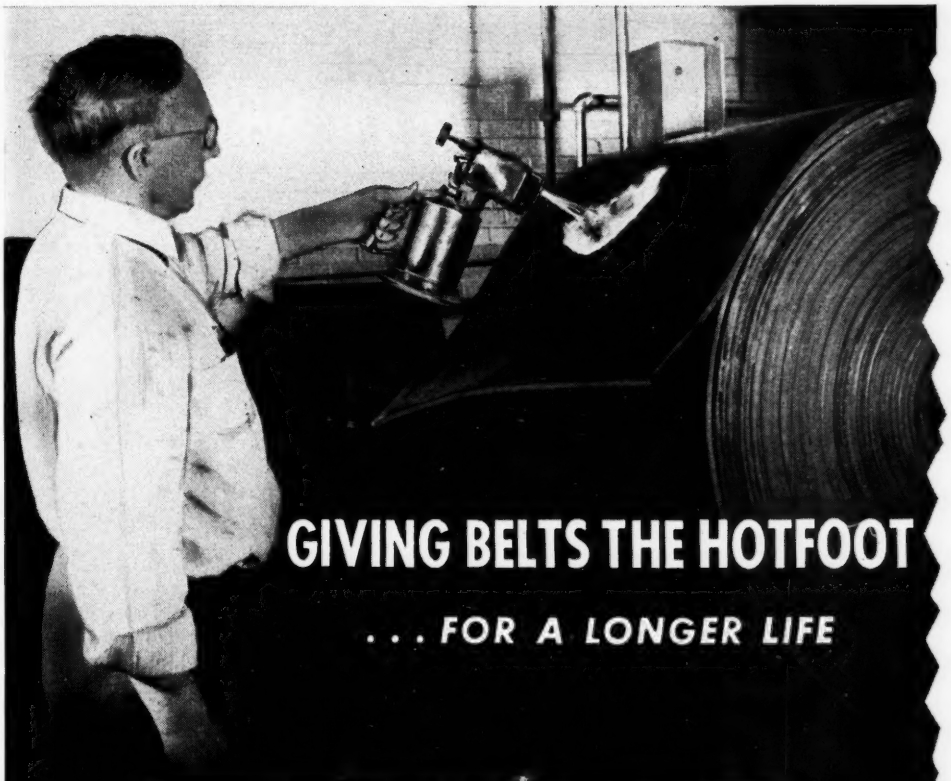
Hall Laboratories studies the uses of steam in your plant, for the nature of these uses determines the *quality* of steam you need, and steam quality must be taken into account in prescribing the treatment best suited to your plant.

Every plant which has Hall service gets *individual attention* —which is one reason why small as well as large plants find this service profitable. Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

HALL LABORATORIES, INC.

(A Subsidiary of Hagan Corporation)

CONSULTANTS ON
INDUSTRIAL WATER TREATMENT
HALL SYSTEM OF BOILER WATER CONDITIONING
INDUSTRIAL WASTE RECOVERY AND DISPOSAL



GIVING BELTS THE HOTFOOT

. . . FOR A LONGER LIFE

QUAKER CONVEYOR BELTS PRE-TESTED 18 TIMES TO ASSURE LONG LIFE UNDER MOST SEVERE CONDITIONS

Coal . . . cinders . . . hot ashes—some hot, others cold and case histories prove Quaker Belts stand up under the most severe usage. They're pre-tested and torture-tested when they are made to withstand every operating condition.

One of the many tests Quaker Conveyor Belts must go through is shown above. A blowtorch, at high heat, held six inches from the surface of the belt for six minutes. Quaker Belts take it and are ready for more. They're tough, rugged and built for longer wear. They're made for the power industry to assure less maintenance . . . to save loss of labor in repairs . . . to help your plant reduce the "break-even point" in its operations.

Whatever your need for industrial rubber products there's a Quaker Pre-tested Product for the Power Industry. Power transmission belting for every type of installation . . . rod and sheet packings . . . moulded and braided hose . . . and all kinds of custom-made moulded rubber products. To economize on power generation costs . . . it pays to Quakerize your plant.

PACKINGS FOR TIGHTER SEALS

Quaker packings are scientifically engineered for every use—for pumps, refrigeration compressors, water lines, valves and the many other places in the Power Industry.

BELTING FOR MAXIMUM HORSEPOWER

Huge flat belts driving large flywheels or small fractional horsepower drives . . . Quaker pre-testing develops belts for every need of the Power Industry...belts to assure peak efficiency.

QUAKER RUBBER CORPORATION

PHILADELPHIA 24, PA. • New York 7 • Cleveland 15 • Chicago 16 • Houston 1
Western Territory:
QUAKER PACIFIC RUBBER CO. • San Francisco 10 • Los Angeles 21 • Seattle 4

QUAKER

RUBBER PRODUCTS

QUAKER RUBBER CORPORATION
PHILADELPHIA, PA.
QUALITY SINCE 1885

REG. U. S. PAT. OFF.

It's repeat orders that count!

DETROIT ROTOGRATE STOKERS

Third—210,000 pound capacity RotoGrate ready for shipment to The Studebaker Corporation—Automotive Plant, South Bend, Ind.

For Greater Economy in Steam Production use Detroit RotoGrate, the original spreader stoker with forward moving, continuously cleaning grates that discharge the ash at the front.

Repeat orders are always convincing proof of satisfaction. RotoGrate users order again and again, because they find that

"Detroit RotoGrate Stokers reduce their cost of producing steam"

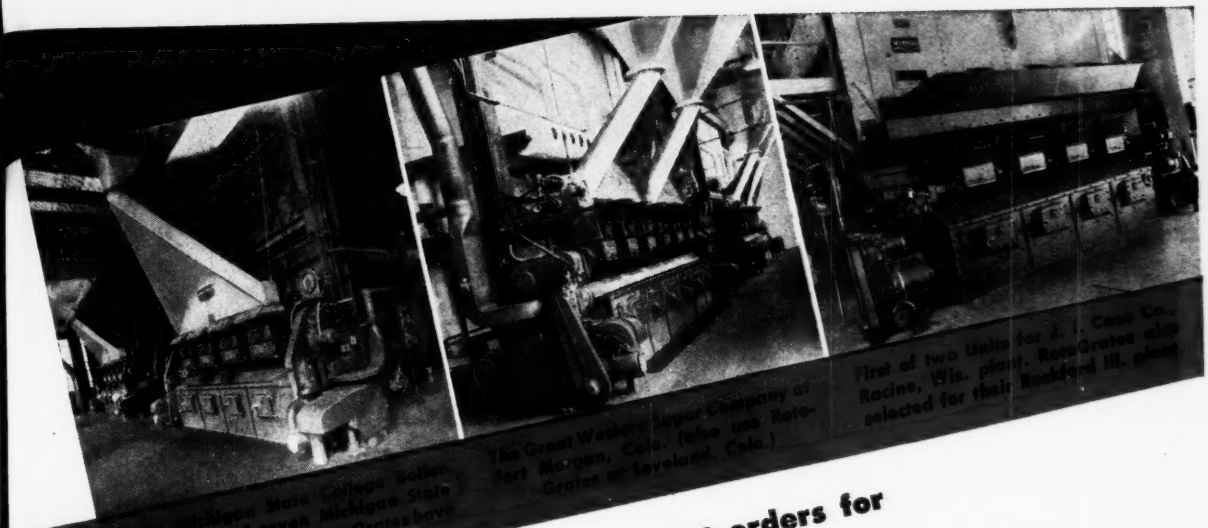
by efficiently burning any Bituminous coal or Lignite. They permit much higher burning rates to produce more capacity per foot of furnace width, thus holding down investments in both generating equipment and building.

RotoGrates handle fluctuating loads, without sacrifice in economy. Reliable availability is high.

May we serve you? • Write for Bulletin.

Other types and sizes of Detroit Stokers for every industrial or power need

DETROIT STOKERS SINCE 1898



Near Michigan State College Boiler Plant: One of seven Michigan State institutions for which RotoGrates have been [illegible]

The Great Western Sugar Company at Fort Morgan, Colo. (also uses RotoGrates at Loveland, Colo.)

First of two Units for J. I. Case Co., Racine, Wis. plant. RotoGrates also selected for their Rockford Ill. plant.

Prominent users who have placed repeat orders for DETROIT ROTOGRATE STOKERS:

- **AMERICAN BOX BOARD CO.**—Two Contracts since 1942; Total capacity, 230,000 lb.
- **CENTRAL ILLINOIS ELECTRIC & GAS CO.**—Four Contracts since 1945; Total capacity, 960,000 lb.
- **CHRYSLER CORP.**—Seven Contracts since 1940; 13 RotoGrates—Total capacity, over 1,000,000 lb.
- **CONSOLIDATED PAPER CO.**—Two Contracts since 1946; Total capacity, 300,000 lb.
- **GENERAL MOTORS CORP.**—Ten Contracts since 1942; 21 RotoGrates—Total capacity, over 1,600,000 lb.
- **INTERNATIONAL PAPER CO.**—Three Contracts since 1948; Total capacity, 335,000 lb.
- **IOWA PUBLIC SERVICE CO.**—Six Contracts since 1941; Total capacity, 600,000 lb.
- **J. I. CASE CO.**—Three Contracts since 1942; Total capacity, 270,000 lb.
- **JOHN DEERE DUBUQUE TRACTOR CO.**—Two Contracts since 1945; Total capacity, 240,000 lb.
- **LEVER BROTHERS CO.**—Two Contracts since 1947; Total capacity, 285,000 lb.
- **MONTANA-DAKOTA UTILITIES CO.**—Two Contracts since 1947; Total capacity, 135,000 lb.
- **MOORHEAD, MINNESOTA MUNICIPAL POWER PLANT**—Two Contracts since 1945; Total capacity, 110,000 lb.
- **MOTOR WHEEL CORP.**—Two Contracts since 1942; Total capacity, 140,000 lb.
- **MUSCATINE, IOWA, MUNICIPAL PLANT**—Two Contracts since 1941; Total capacity, 260,000 lb.
- **NEW YORK CENTRAL SYSTEM**—Two Contracts since 1947; Total capacity, 125,000 lb.
- **NORTHERN STATES POWER CO.**—Five Contracts since 1946; Total capacity, 900,000 lb.
- **PETER COOPER CORPORATIONS**—Three Contracts since 1946; Total capacity, 220,000 lb.
- **PUBLIC SERVICE COMPANY OF OKLAHOMA**—Three contracts since 1941; Total capacity 625,000 lb.
- **PULLMAN STANDARD CAR MANUFACTURING CO.**—Two Contracts since 1945; Total capacity, 240,000 lb.
- **ROHM & HAAS CO.**—Three Contracts since 1946; Total capacity, 325,000 lb.
- **SIOUX CITY GAS AND ELECTRIC CO.**—Two Contracts since 1944; Total capacity, 170,000 lb.
- **STATE OF MICHIGAN**—Ten Contracts since 1945; 18 RotoGrates for 7 institutions; Total cap., 912,000 lb.
- **STATE UNIVERSITY OF IOWA**—Two Contracts since 1938; Total capacity, 178,000 lb.
- **TENNESSEE EASTMAN CORP.**—Three Contracts since 1946; Total capacity, 525,000 lb.
- **THE GREAT WESTERN SUGAR CO.**—Two Contracts since 1946; Total capacity, 500,000 lb.
- **THE NORTHWEST PAPER CO.**—Two Contracts since 1945; Total capacity, 200,000 lb.
- **THE STUDEBAKER CORP.**—Three Contracts for Automotive Plant—Total 630,000 lb, and one Contract for Truck Plant—Total 150,000 lb, all since 1940.
- **WALWORTH COMPANY, INC.**—Two Contracts since 1943; Total capacity, 120,000 lb.
- **WEST VIRGINIA PULP & PAPER CO.**—Three Contracts since 1944; Total cap., 400,000 lb.

DETROIT STOKER COMPANY

GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

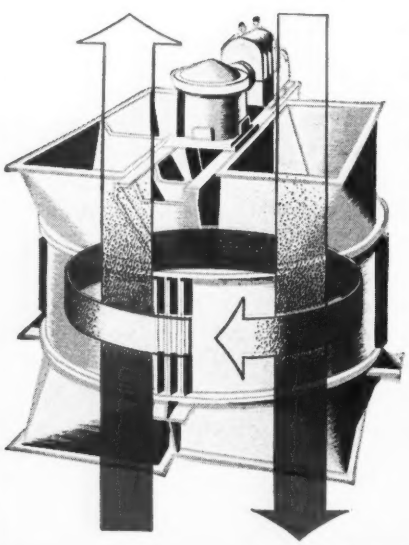
Works at Monroe, Michigan, District Offices in Principal Cities

Fact File on Preheat

No. 2

In the Ljungstrom Air Preheater, air and flue gases are each uniformly distributed as they flow through the heating surface. This uniform flow through the rotating heating element maintains nearly constant temperatures at any given cross-section. "Cold spots," which often initiate plugging, do not exist at any part of the heat exchange surface.

LJUNGSTROM



The Ljungstrom Air Preheater is a compact gas-to-air or gas-to-gas heat exchanger, operating on a continuous regenerative counterflow basis. Hundreds of power plants and other special applications confirm its high level of heat recovery and long-term service at low maintenance expense.

THE

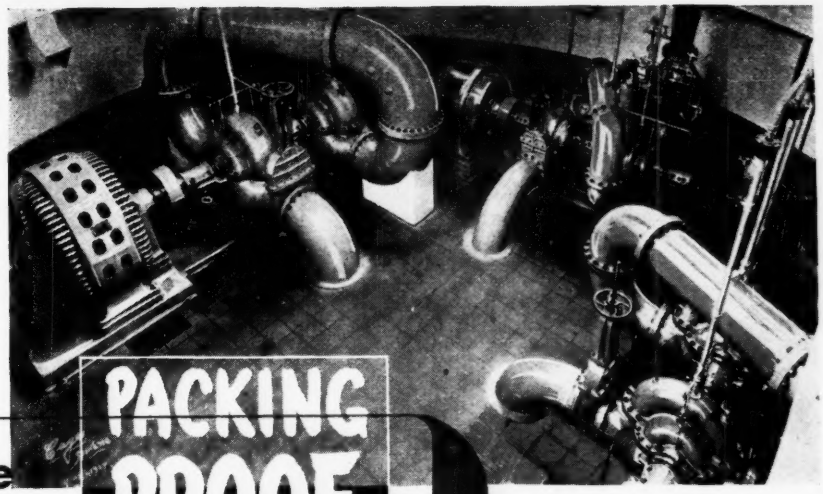
AIR PREHEATER CORPORATION

60 EAST 42ND STREET · NEW YORK 17, N. Y.

Plant: Wellsville, N. Y. 960

PHOTO OF....

DeLaval Centrifugal pumps in the Well Pumping Station of the City of Spokane Water Department.



Here's PACKING PROOF

CITY OF SPOKANE

DEPARTMENT OF PUBLIC UTILITIES
WILLARD "DUKE" TAFT
COMMISSIONER OF PUBLIC UTILITIES

ELMO JAMES, MEM. A.W.W.A.
SUPERINTENDENT OF WATER

March 8, 1949

A. E. Rains,
Rains Wood-Metal Packings
904 W. Broadway Ave.
Spokane, Washington

Dear Mrs. Rains:

Our records show that "Rains Standard Packing" was installed in the Well Pumping Station in #1, #2 and #3 De Laval Centrifugal pumps during 1926 - 1927. These pumps operate under an 8 to 10 foot lift and from 225 to 400 foot discharge head and delivery of 5,555,000 - 12,000,000 and 24,000,000 gallons respectfully.

In December, 1938, #2 pump required new impellers and the original Rains Packing had to be disturbed. The old packing showed a perfect bearing formation, and the old bronze sleeves which were already somewhat grooved before Rains Packing was installed, showed no further wear after such a long period of operation. Rains Packing was reinstalled in this pump and has been in service ever since.

The original Rains Packing in #1 and #3 pumps is still intact after 22 years of service.

Since the installation of Rains Packing, these pumps have operated within 92% to 95% of efficiency and have never lost their prime.

These pumps were installed in 1926. The original packing was taken out and replaced with Rains Standard Packing and shortly after placed in service.

Very truly yours,

Elmo James
Elmo James,
Superintendent of Water

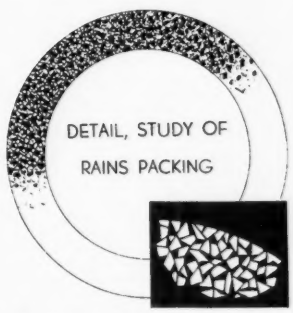
RAINS

WOOD•METAL PACKINGS

904 W. Broadway
Spokane, Washington, U. S. A.

1 LOW FRICTIONAL LOAD . . . the lubrication impregnated wood units act as reservoirs of lubrication throughout every fraction of a square inch of the packing. This creates osmotic action within the packing in operation causing a continuous seepage of lubrication on the rod or shaft forming an almost frictionless surface.

2 HIGH SEALING CAPACITY . . . is attained by the special angular shape of the wood and metal units, because they arrange themselves around the rod or shaft, forming a bearing-like wearing surface, completely leak-proof.



3 SAVES ROD AND SHAFT REPLACEMENTS . . . in all cases where Rains Wood-Metal Packing has been used, the original rods and shafts are still in operation and in a highly polished condition.

4 DURABILITY, ADAPTABILITY . . . Rains Packings reduce packing bills from 50% up to several 100%—and can be used on any piece of mechanical equipment having a standard stuffing box . . . on either rotating or reciprocating motion, rods, stems or shafts—and on pressures to 10,000 lbs.

Proof on any type of pump furnished on request.

When ordering new equipment . . . Specify Rains Packing

HAGAN controls

AT THE McKEESPORT PLANT OF KELSEY-HAYES WHEEL COMPANY

Kelsey-Hayes Wheel Company, manufacturer of steel wheels for automobiles, farm implements, etc., is one of the companies which have acquired manufacturing facilities in the Pittsburgh area in recent years.

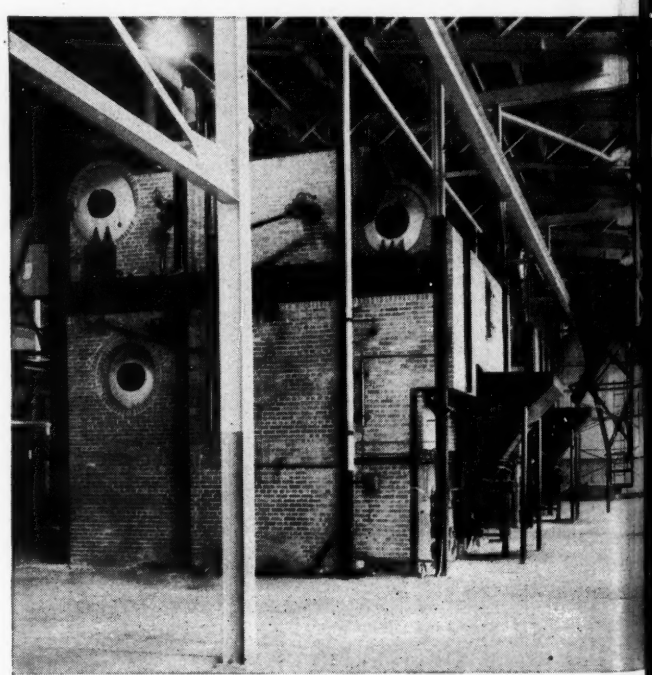
The plant purchased by them was previously used for certain work of Jones & Laughlin Steel Corporation, and before that was occupied by the McKeesport Tin Plate Co. The problem confronting Kelsey-Hayes was to get in production quickly, and to continue production while virtually constructing a new plant within the walls of the old. This work is being handled by the Austin Company, Cleveland engineers and builders.

One of the first steps was the construction of a new steam plant, since the new type of operation requires better heating facilities. In addition, some steam is required for the pickling tanks. It was necessary also to provide for expanding boiler room facilities to keep pace with steam demand when the plant is in full production.

In its present stage, the plant has two stoker-fired, 160-lb. boilers, with capacities of 25,000 lb./hr. and 45,000 lb./hr. respectively. Both boilers are equipped with Hagan Automatic Combustion Control and Hagan Ring Balance Boiler Meters.

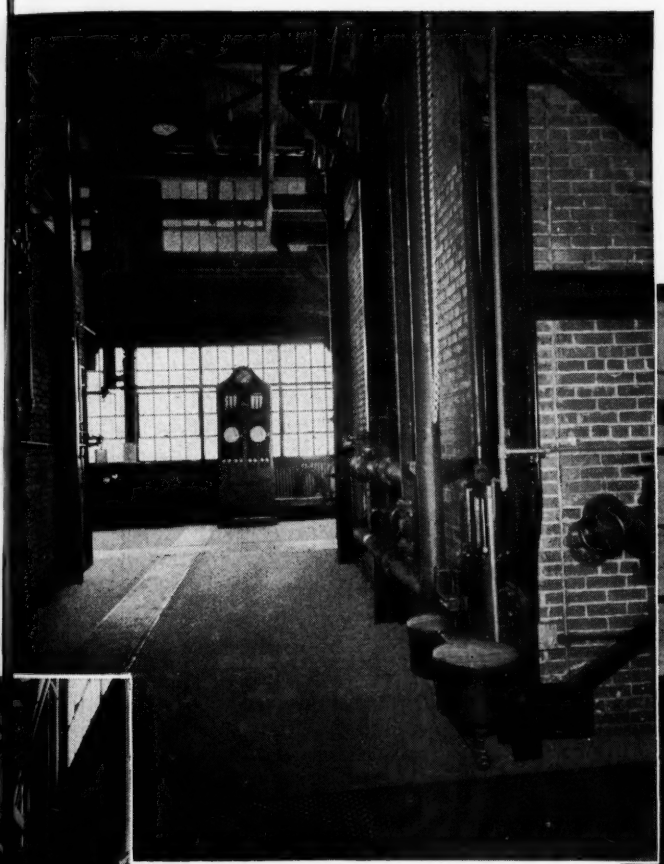
These meters are the three-pen-type, providing records of steam flow, air flow, and flue gas temperature on a single chart. Steam flow is also shown on a strip indicator, and is continuously totalized by the Hagan Ring Balance integrator with which each meter is equipped.

For full information on Hagan Controls and Hagan Ring Balance Flow Meters, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

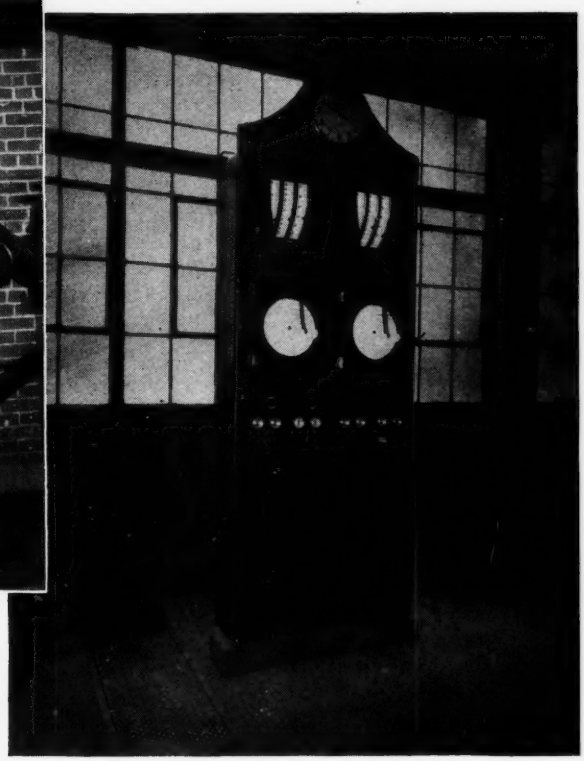


View of the first two new boilers at Kelsey-Hayes. R. D. Craighead is General Foreman in charge, F. V. Hopke is boiler room foreman.

...ol and meters—



View between boilers, looking toward control panel. Hagan Balanced Float Controller is shown at corner of boiler on the right. This element of the Hagan Control System operates uptake damper.



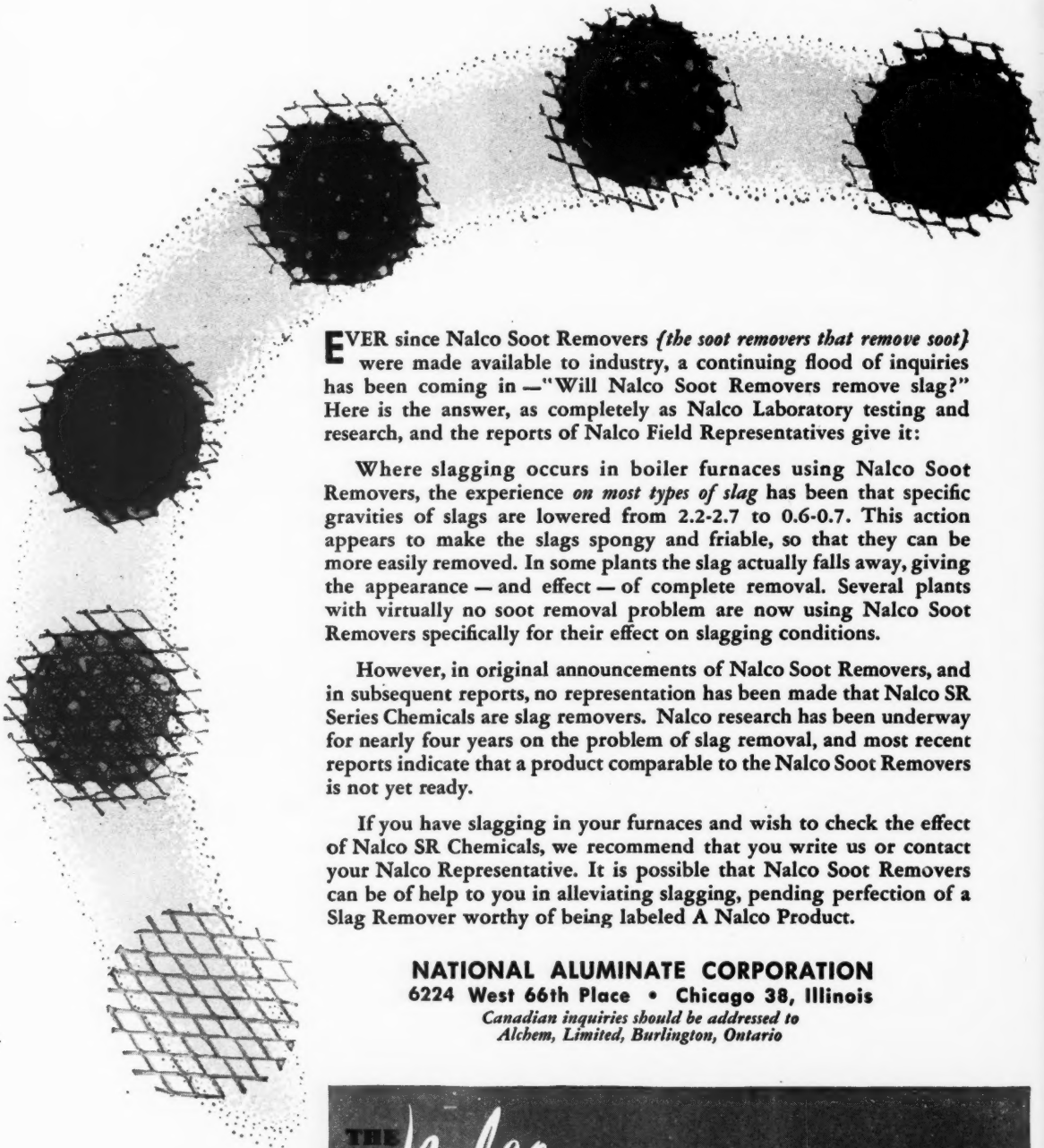
Control panel showing Hagan Controls and Hagan Ring Balance Boiler Meters. Meters record flue gas temperature also, and are equipped with strip indicator for steam flow.

HAGAN HALL BUROMIN CALGON

HAGAN CORPORATION

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

DO *Nalco* SOOT REMOVERS REMOVE **SLAG?**



EVER since Nalco Soot Removers *{the soot removers that remove soot}* were made available to industry, a continuing flood of inquiries has been coming in —"Will Nalco Soot Removers remove slag?" Here is the answer, as completely as Nalco Laboratory testing and research, and the reports of Nalco Field Representatives give it:

Where slagging occurs in boiler furnaces using Nalco Soot Removers, the experience *on most types of slag* has been that specific gravities of slags are lowered from 2.2-2.7 to 0.6-0.7. This action appears to make the slags spongy and friable, so that they can be more easily removed. In some plants the slag actually falls away, giving the appearance — and effect — of complete removal. Several plants with virtually no soot removal problem are now using Nalco Soot Removers specifically for their effect on slagging conditions.

However, in original announcements of Nalco Soot Removers, and in subsequent reports, no representation has been made that Nalco SR Series Chemicals are slag removers. Nalco research has been underway for nearly four years on the problem of slag removal, and most recent reports indicate that a product comparable to the Nalco Soot Removers is not yet ready.

If you have slagging in your furnaces and wish to check the effect of Nalco SR Chemicals, we recommend that you write us or contact your Nalco Representative. It is possible that Nalco Soot Removers can be of help to you in alleviating slagging, pending perfection of a Slag Remover worthy of being labeled A Nalco Product.

NATIONAL ALUMINATE CORPORATION
6224 West 66th Place • Chicago 38, Illinois
Canadian inquiries should be addressed to
Alchem, Limited, Burlington, Ontario

THE *Nalco* SYSTEM . . . Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

BOILERS AND AUXILIARIES

101 **Steel Boiler Catalog**—Low and high pressure boilers for heating and for power and process steam are illustrated and described in detail in General Catalog 80, 24 pp. It covers steel boilers for oil, gas, stoker or hand fired coal, and includes photographs, complete dimensional data, ratings and specifications. Kewanee Boiler Corp.

102 **Working Pressure Data Card**—Maximum allowable working pressures for water tube and fire tube boilers are compiled in a handy reference table, Technical Data Card No. 113 A. It lists pressures in pounds per square inch for seamless and electric resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to ASME specifications. Chart covers 2 letter-size pages, is printed on firm stock, and punched for use in binder. The Babcock & Wilcox Tube Co.

103 **Steam Generator Data**—Described as a data book for engineers and architects, this is a collection of approximately 100 pp of excellent information on automatic and semi-automatic steam generators in sizes up to 500 hp. Should be of value to anyone planning to install a steam generator, since it not only provides information about the generators themselves, but also provides installation tips and boiler room layouts. The book includes recent bulletins published on manufacturer's line of generators as well as data sheets giving general information and specifications on different models available for gas, oil or combination fuel operation. Also includes photos, sketches, cross section drawings and dimensional diagrams. In loose-leaf binder. Cleaver-Brooks Co.

104 **Blast Furnace Gas Burner Bulletin**—Said to be the first published on the subject, Bulletin No. 500, 4 pp, describes operation of these burners and discusses their adaptability for use not only with waste fuels, but also in combination with auxiliary fuels and by means of auxiliary fuels alone. Contains pictures of gas burner installations and cross section drawings of various other types of burners for waste and primary fuels. Peabody Engineering Corp.

105 **Oil Burner Catalog**—An oil burner designed especially for manufacturer's line of internal fireboxes is described and illustrated in 10-pp Part 6, Section 3 of General Catalog 54. It tells how this burner is powered, where and how it should be installed and how it works. Includes specifications and shipping weights for typical installations. Illustrations include photos and cut-away drawings. Black, Sivalls & Bryson, Inc.

106 **Boiler Girth Seam Protection**—This illustrated folder describes an improved protective section designed to prevent leaking and fire cracking on new boiler seams and to stop such damage on old seams. Photos and sketches showing the parts of a complete section are accompanied by information on how the sections are made, how they're applied and how to order them. National Boiler Protector Co.

107 **Refractory Bulletin**—"Here's Longer Life for Your Furnace Lining," is the title of a new 2-pp bulletin on plastic fire brick. It explains how this monolithic lining withstands destructive furnace atmospheres and helps increase furnace efficiency. Tells applications for both the regular and heavy duty qualities available, how they're packaged and how to estimate poundage needed for a particular job. Walsh Refractories Corp.

108 **Jaw Crusher Bulletin**—An improved jaw crusher which crushes by pressure only is described and illustrated in 12-pp Bulletin 5011. By means of cross section sketches it shows how this crusher works, as compared to the way in which early models of crusher worked. Includes a detailed explanation of machine's operation and description of all parts and features. Also explains crusher's large capacity, why it requires less power per ton crushed. Contains installation data, complete specifications. Illustrated with photos of models, typical installations, diagrammatic sketches. Also includes inquiry form. Punched for binding. Pennsylvania Crusher Co.

PIPING AND VALVES

109 **Piping Materials Catalog**—Corrosion resistant valves and piping materials are covered in illustrated Circular No. 320, 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawings of models, complete specifications, sizes and prices. Includes a description of alloy metals used and a corrosion questionnaire. Also included are several pages of condensed recommendations on the selection of piping materials according to service requirements as well as a pictorial chart showing basic types of valves with names of their component parts. Crane Co.

110 **Insulated Piping Data**—Section 480-3, 40 pp, contains engineering drawings of insulated pipe installations to illustrate manufacturer's engineering drawing service. According to manufacturer, these drawings, selected at random from thousands, show that given complete information about a plant's requirements and conditions, an entire piping system may be economically designed and prefabricated at the factory ready for installation at the plant. Many industrial and utilities installations are included among these drawings. The Ric-Wil Co.

111 **Flexible Metal Hose Catalog**—Said to be one of the most inclusive books issued on flexible metal hose products, Catalog G-50, 68 pp, was compiled as a self-contained source of information on the subject. It contains full descriptions and complete specifications and installation data for standard types of flexible hose in a variety of metals. Other sections are devoted to expansion joints for piping systems, stainless steel and brass bellows, and various conduits and special assemblies of these components. Included are photographs showing the testing of materials used in manufacturer's products and photos of flexible hose in use. There's also a chart showing relative metal hose values and an explanation of technical terminology used in the book. Chicago Metal Hose Corp.

112 **Relief Valves**—Bulletin No. 711, 4 pp, illustrates and describes globe and angle type relief valves for protecting equipment against abnormal pressure increases. It tells applications for these valves and discusses design detail, springs and seating, also installation and maintenance. Includes dimensions. Illustrated with photos of valves and an installation, also a cut-away drawing showing construction. Edward Valves, Inc.

113 **Steam Specialties**—Catalog No. 68A, 32 pp, contains information on manufacturer's line of traps, strainers, reducing valves and separators, including complete specifications and recommendations for use in typical applications. Lists prices on all equipment. Also provides tips on the selection, sizing and maintenance of traps. Has illustrated index which is in itself a quick reference data-table. Includes photos and cut-away illustrations of models, installation diagrams, also steam table. Strong, Carlisle & Hammond Co.

HEATERS

114 **Fan Heater Bulletin**—Here's a 2-pp illustrated bulletin (No. 109) on a new high pressure steam fan heater designed for complete utilization of both sensible and latent heat of high pressure steam. One page is devoted to description and photos of the heater. Other page contains a sketch in color showing how the heater works. Niagara Blower Co.

115 **Unit Heater Data**—A general description of manufacturer's unit heaters and accessories as well as engineering data on them is contained in Bulletin No. 103, 20 pp. It covers V-belt drive and direct connected units of the floor mounted, vertically suspended and horizontally suspended types. Includes capacity tables for available models, also tables giving Btu constants and steam data. Photos show several models and installations. Clarage Fan Co.

DUST COLLECTING

116 **Dust Collectors**—Dust collecting equipment for power plants, foundries, cement plants and similar industries is the subject of Bulletin No. 1428, 26 pp. Contains many photographs of installations, also photos showing equipment being tested in company laboratories. Discusses services offered by manufacturer in analyzing individual installation requirements and recommending equipment for the job. American Blower Corp.

117 **Automatic Filter Bulletin**—A new model 4-stage automatic self-cleaning filter for handling large air volumes and heavy dust loads is introduced in this 8-pp bulletin. It lists important advantages offered by this filter, tells its applications and describes its construction and operation. Includes specifications, performance data and shipping weights. Illustrations include photos of the filter and parts, and a cross sectional layout of equipment used in central air conditioning. Dollinger Corp.

MAY, 1949
Card Void in 6 months

POWER GENERATION

Please have the manufacturers send me without obligation information or bulletins indicated by the following item numbers.

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Your Name.....

Your Title.....

Your Company Name.....

Company Address.....

City..... State.....

(If you prefer delivery at your home also fill below)

Home Address.....

City..... State.....

SEPARATION

118 **Pressure Drop Chart for Steam Separators**—To facilitate selection of a steam separator for given conditions, this chart is designed for selection of most efficient size and type of steam separator for a specific installation and determination of pressure drop through the separator. Included also is a method for determining pressure drop on an oil separator for an exhaust steam line. Three typical examples are given to show method for determining pressure drop. Two tables give steam flow through various types of the manufacturer's steam separators at pressures from 0 to 250 psig. The chart is also included in a new catalog, No. 500, which describes in detail the various separators for use on steam, oil, air and gas, also exhaust heads, furnished by the manufacturer. The catalog also shows charts of engine and turbine steam ratio and pressure drop and velocity in steam piping. Wright-Austin Co.

119 **Filtering, Separating**—"Little Known Ways to Save Big Money with Fine Wire," is the title of Bulletin 11, 8 pp, concerning separation in mist extraction, gas filtering, tower packing, cleaning and baffling with manufacturer's elements of technical knitted mesh. It describes and illustrates the construction of these elements and stresses economy afforded by using them. Also illustrates recommended installation practices. Includes inquiry sheet. Otto H. York Co., Inc.

ELECTRICAL

120 **Motor Bulletin**—Technical data on single-phase motors of both the capacitor start-induction run and capacitor start-capacitor run types is provided in Bulletin No. 722, covering 8 letter-size sheets. It explains the operation of single-phase motors and includes a typical performance chart and a typical speed torque curve. Also includes connection diagrams and photos of motor control units. The Louis Allis Co.

121 **Generator Switchgear Bulletin**—Described in this 12-pp booklet are manufacturer's pre-engineered switchgear for low voltage, single generators, low voltage paralleled generators and high voltage paralleled generators. Contains photos, panel specifications and connection diagrams of each type. Also includes general explanation of what pre-engineered switchgear equipment provides, its advantages, applications, selection and installation, and a description of the circuit breakers, disconnect switches and panel construction incorporated in the switchgear. Electric Machinery Mfg. Co.

122 **A-C Generator Booklet**—Excellent information on how to select a-c generators, paralleling of a-c generators, boosting capacity to meet electric power demands and the application of packaged generators in industry is contained in this 16-pp bulletin, EM Synchronizer No. 27. It's illustrated with many photos of a-c generators and installations and performance charts. Includes a check list of factors to be considered in selecting a-c generators and tables showing types of generator service and generator voltage. Electric Machinery Mfg. Co.

123 **Pole Buyers' Guide**—This 18-pp illustrated technical bulletin is an informative guide for users and buyers of poles. It presents service records, electrical resistance information and comparative cost figures of pressure-creosoted poles. Gives complete specifications and defines wood terminology. Five tables of dimensions for different kinds of poles are included, along with a diagram showing measurement of sweep and short crook in poles. Also discusses proper unloading techniques to prevent injury to workmen and damage to poles, and describes treating facilities available. Wood Preserving Div., Koppers Co., Inc.

124 **How Meters Are Made**—Anyone interested in knowing about the workmanship in the production of technical instruments should read Bulletin No. 800 which contains 8 pp of photographs devoted to the construction of mechanical and electrical flow meters. These photos take in practically every step of the process from the initial inspection of parts, through their assembly and the calibration of the meter to the final inspection before shipment. Penn Industrial Instrument Corp.

125 **Electric Control Device Catalog**—Containing more than 200 pp, this new catalog gives full descriptions and up-to-date technical data on manufacturer's complete line of resistors, rheostats, relays, contactors, motor starters and controllers, as well as control accessories. Technical data includes ratings, specifications and dimensions. Book is generously illustrated with photographs and sketches, contains current prices and lists bulletins published by manufacturer which deal with specific types of control equipment. It's indexed for easy reference and includes both general definitions and definitions of trade names. Attractively bound, has leather-like, loose-leaf cover. Ward Leonard Electric Co.

126 **Recorders and Controls**—In addition to listing manufacturer's instruments for recording and controlling pH and conductivity, Catalog No. 15-12 contains an explanation of the value of electronic measurements and the fundamentals of pH, oxidation-reduction potential and conductivity. It also discusses measuring and control systems and describes their applications. Includes photographs and complete specifications for recorders, controllers, potentiometers, amplifiers and accessories; also installation diagrams. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

127 **Flow Tube**—In a 6-page, illustrated bulletin the Bethlehem Flow Tube (Gentile Patents) is described and illustrated in detail. The bulletin discusses first the construction of the tube, designed to improve measurement, regulation and control of fluid flow. The principle of operation is given in detail with analysis of the mathematics of flow through the tube. Summary of performance data, with curves, is also included. The tube is designed to produce a differential in a flow line which can be measured by a standard flow meter. Bethlehem Foundry and Machine Co.

BELTS, BELTING

128 **Conveyor Belt Data**—Catalog Section 2200, 6 pp, describes cord conveyor belts designed for high impact resistance, flexibility and long life. It covers several types of cord belts, illustrates their construction, gives specifications and tells how to select them according to service conditions. Also describes and illustrates special conveyor belts for unusual loading conditions. Lists approximate net weights. The B. F. Goodrich Co.

129 **Portable Belt Conveyor Bulletin**—All-purpose, high capacity portable conveyors with plain or cleated belts are the subject of 8-pp Bulletin 363. Two pages of sketches illustrate suggested applications for these conveyors and show how they can be adapted to various conditions. Bulletin also contains photographs of major construction details. It stresses economy of these portable conveyors in cutting handling costs of bulk materials. Barber-Greene Co.

130 **Belting Catalog**—The advantages and applications of "Veelos" balata belting, a heavy-duty, waterproof V-belting for power transmission, elevating and conveying, are given in this 4-pp catalog-folder. It also gives specifications, lists prices and contains several photos of these belts in actual service. Manheim Mfg. & Belting Co.

WATER TREATMENT, CORROSION PREVENTION

131 **Water Demineralizer Booklet**—The economy and other advantages of manufacturer's demineralizers are convincingly presented in this 26-pp booklet. It emphasizes the role of demineralizers in providing a low-cost chemical equivalent to distilled water. It explains and illustrates, by colored sketches, how ion exchange can be utilized to remove dissolved solids from tap water; tells how this principle is applied in demineralizing equipment and how this equipment is operated and how to calculate time required for a run. Booklet includes estimate of operating costs in several cities. Describes and illustrates available demineralizer models and gives their specifications. Ion Exchange Products Dept., American Cyanamid Co.

132 **Corrosion Resistance of Nickel Alloys**—Technical Bulletin T-3 contains 44-pp of illustrated information on the resistance of high nickel alloys to corrosion by sulfuric acid. Although technical in nature, it is written so as to be readily understood by non-technical staffs. Performance of 30 nickel-bearing materials in a wide range of service is discussed, and there are 86 tables and 33 graphs and photos in addition to text. Problems involving a wide range of operations from the pickling of steel to petroleum refining and textile processing are covered. The International Nickel Co., Inc.

133 **Magnesium Anode Data**—General information on magnesium anodes for cathodic protection of pipe lines and other metal structures is provided in 5 letter-size sheets. It covers applications of cast, packaged, flexible ribbon and extruded anodes. Gives composition of magnesium alloy used and includes ratings, dimensions, sketches and prices. Dowell Inc.

MISCELLANEOUS

134 **Crane Catalog**—A Diesel locomotive crane of 30 t capacity is described and illustrated in 20-pp Catalog No. 600-L-6. It explains the advantages of this crane, including improved magnet operation, high-speed grab bucket work, increased safety in grapple work and accuracy and flexibility of hook work. Describes in detail the car body, transmission, interlocking gib ring and roller path, clutch assembly, deck machinery and boom hoist. Illustrations include photos of cranes at work and photos showing parts and construction details, also sketch showing safe lifting capacities. American Hoist & Derrick Co.

135 **Automatic Oilers**—Here's a 12-pp booklet filled with photographs of actual job installations of visible automatic oilers in a wide range of applications. It provides many useful tips on the correct use of oilers. Types illustrated and described include constant level, wick, thermal, and gravity fed oilers. Trico Fuse Mfg. Co.

136 **Soldering Tool Announcement**—"Pres-to-Heat," a new electric soldering device, designed to hold and clamp the work while it is being soldered, is introduced in this 4-pp bulletin. Contains photos of the tool and its power unit and describes its methods of operation and advantages. The Housing Foundation, Inc.

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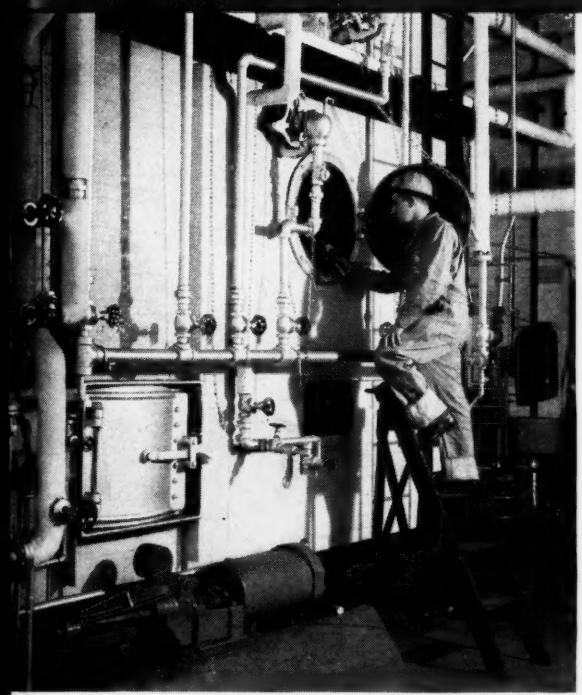

Dowell engineer checking boiler temperature with a pyrometer during chemical cleaning.

RESTORE LOST POWER...

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THE DOWELL *service* method of removing scale and sludge from heat exchange equipment has become a regular part of the maintenance program in many industrial plants. Operators have found that giving their cleaning problems to *experienced* Dowell engineers has resulted in the fast, convenient restoration of efficiency and lost power.

The unit to be cleaned is filled with liquid chemical solvents, selected for the particular job and designed to clean away scale and sludge even in the hard-to-reach places, wherever water and steam flow.

Dowell Chemical Scale Removal Service has a place in your plant. Skilled engineers, specially designed pumping and control equipment, tested solvents and proved processes have stepped up cleanliness standards to new highs. Here is a modern answer to power and maintenance engineers' demands for rapid, convenient, economical cleaning. Ask the office nearest you for a free cost estimate.

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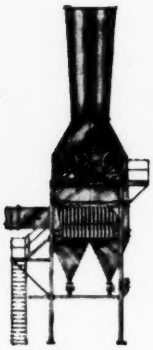

The Secret of CONTROL

Thermix Fan Stacks produce a definite controlled degree of draft—because in a unit packaged design they combine, (1) the induced draft fan, (2) the breeching connecting the fan and stack and (3) the stack itself. All *three* are interdependent and affect the controlled, overall operation. To design, engineer and purchase these parts separately would not produce the same accurate, known results that this packaged unit offers.

And what about Tubular Dust Collectors? Thermix offers multiple small diameter tubes for high centrifugal force and resulting efficiency, plus the added advantage of smaller space requirements and more accurate dust control for your plant.

A call to the field engineer nearest you will place at your disposal a specialist in the field of flue gas control.

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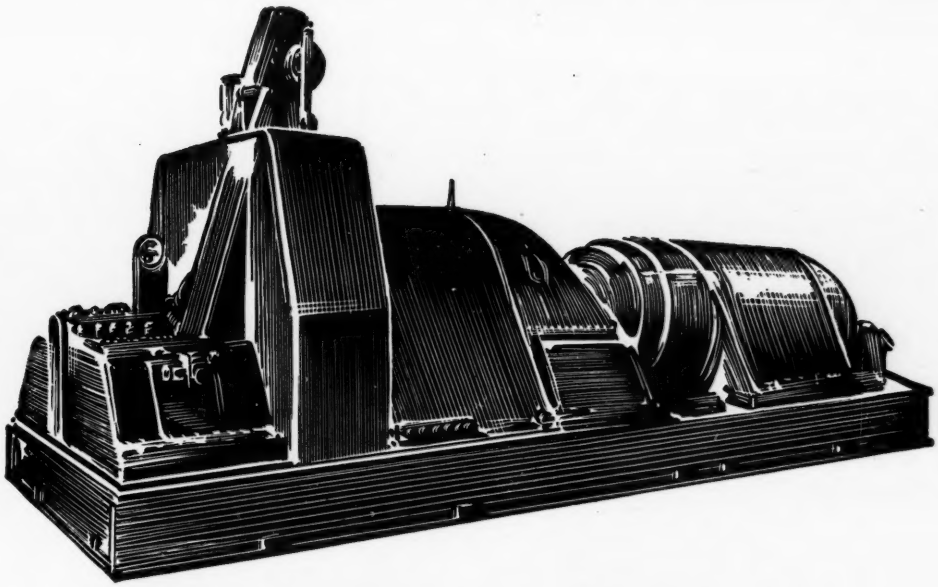

POWER IS CHEAP

WHEN PRODUCED AS A BY-PRODUCT

Wherever steam also is required in appreciable quantities for heating or processing, power can be produced at surprisingly low cost with a turbine designed for extraction or back pressure service. Often the cost of the small amount additional fuel required to produce power is so low that the entire equipment investment can be repaid in a few years' time.

Whether or not you can save money by producing your own power can be definitely determined from cost figures submitted by our engineers.

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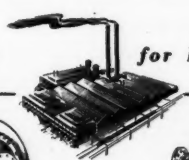
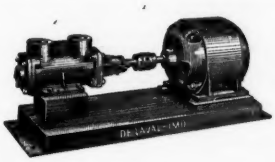
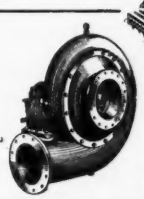
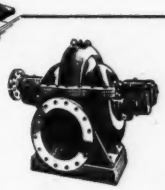
De Laval  *for Industry*







T-11

DE LAVAL STEAM TURBINE COMPANY • TRENTON 2, N. J.

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

How to get a "SWEET" CONTROL JOB

There's More to Boiler Controls Than Regulators

If you want a sweet running control for your boiler plant—look to more than bare regulators when you write your specifications. Here are some additional points to consider:

1 *Insist on controllable equipment*

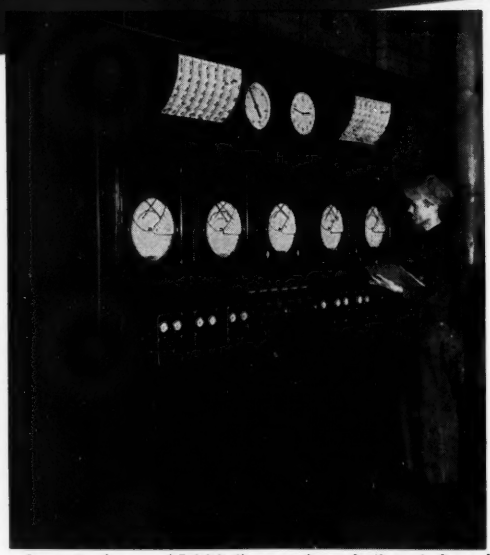
Fans, dampers, pulverizers, stokers, burners, and other equipment must be adaptable to automatic control before any system can give truly satisfactory results.

2 *Control from all important variables*

Multiple element control systems which respond to all of the important variables, insure against costly disturbances in plant operation. They increase safety, decrease auxiliary power required, and reduce the storage capacity needed in heaters and boiler drums.

3 *Profit from the experience of others*

Steam plants similar to yours already are being operated at optimum performance by Bailey Boiler Control. Your dividends, from our experience in making thousands of boiler control installations, take the form of refinements in control application which insure trouble free operation. Over 8,000 boiler units have been equipped with Bailey Controls during the past ten years. These units range from 3,000 to 1,000,000 pounds per hour capacity and operate at pressures from 75 to 2,500 psi. They are fired by pulverized coal, stokers, oil, gas, mixed fuels and waste fuels.



Control of two 65,000 lb. per hour boilers is based on the accurate measurements of these Bailey Meters at The White Motor Co., Cleveland, Ohio. Day to day evaporation runs consistently above the guarantee.

4 *Operate control from accurate measurements*

A control system is no better than the measurements to which it responds. Bailey Controls are based on accurate measurements made by Bailey Meters.

5 *Consult Qualified Application Engineers*

Bailey Engineers are qualified by training and experience to consult with you on both the theoretical and practical aspects of your boiler control problems. These specialists are conveniently located in over 30 industrial areas throughout the United States and Canada.

Details for Your Problems

If you want details write for a copy of Bulletin 15-D or ask a Bailey Engineer to call.

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NEW EQUIPMENT NEWS

Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying number or numbers in the space provided, clip the coupon and send it to Power Generation, 53 West Jackson Boulevard, Chicago 4, Illinois

1—SMOKE INDICATOR

Facilitates compliance with smoke abatement ordinances

This new smoke density indicator and control is designed to indicate industrial smoke density levels. It can also be used to control over-the-fire heated air to the fire-box to reduce excessive smoke. Equipment consists of a light source, phototube holder, and enclosure containing the required control and incorporating an indicator calibrated in Ringlemann units, all in one packaged unit. A recorder, either of the continuous strip chart type or the circular "step" type, can be furnished. The equipment is said to be sturdy and dust-tight. The water-tight phototube holder is easily mounted on ductwork or stack, indoors or outdoors.

In operation, a magnetic relay is set to operate when smoke density reaches predetermined level, such as 35 per cent, at which time a blower forces over-the-fire heated air to the firebox until the smoke density drops to approximately 15 per cent. Should smoke density again rise, the relay is immediately energized. Each time the relay operates an alarm is sounded to warn the boiler operator to adjust the drafts. Used with this equipment, a chart type recorder provides a continuous record of smoke density. The circular type recorder provides a record of the number of times the predetermined smoke density level is reached. Control Div., General Electric Co.

2—WATER COOLING TOWER

Is compact, packaged unit of 7½ t capacity; all steel construction

An Aquatower in the 7½ t bracket has been added to manufacturer's Aquatower line. Like the other models, this one is designed for compactness and quiet operation, indoors or out. It has all-steel construction, bearing housing with grease-packed ball bearings, nailless removable redwood filling and basin integral with tower casing. Electric motors are 3-phase, 60 cycle, 220 or 440 v. Available for immediate shipment and completely packaged, it's ready for operation as soon as water and electrical connections are made. The Marley Co., Inc.

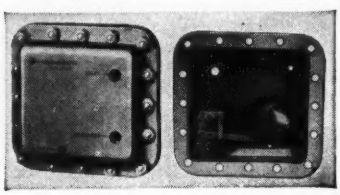
3—CONTINUOUS FLOW TRAP

For quick removal of water, oil, dirt and condensates

This is described as a steady, continuous uniform flow trap for use on steam, gas and compressed air lines. Designed to eliminate alternate "fill and spill" steam and heat losses, steam, air and gas pressure drops, air binding, "freeze-ups," hammer and chatter. Large capacity, trap may be incorporated into air or fuel separators, line purifiers, gas accumulators, superheated drains, process tanks, after absorbers, pipe lines and other steam storing or conditioning equipment.

Steam, gas or air condensate mixture enters trap above the condensate. A slide valve and float mechanism regulates flow of condensate according to volume accumulation in trap. Outlet valve is intended to seal tightly when no condensation takes place and to prevent unnecessary steam and heat losses.

Cast housing contains inlet and outlet, slide valve, lever and float. Stainless steel mechanism may be cleaned without breaking line or removing trap. Air is released by hand-operated valve, but thermostatic air release up to 100 lb pressure may be furnished. In screwed or flanged types for ½, ¾ and 1 in. pipe sizes, and for pressures of 150 and 300 psi and temperatures up to 750 F. Orifices are interchangeable, permitting increased flow rate by change of orifice size. Since both inlet and outlet are on same side of housing it's easy to provide for a bypass. W. S. Rockwell Co.

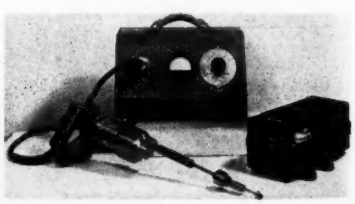


4—TUBE EXPANDER

Is built for precision expanding of condenser tubes

According to manufacturer, this electrically controlled tube expander is capable of precision tube expanding even when operated by inexperienced workers. Known as the Dudley Electronic Control, it is said to increase the speed of expanding tubes, eliminate tube over-expanding, reduce erosion possibilities, and extend tube life. The unit consists of an electronic precision tube expander control, an automatic voltage regulator, the electric expander driving motor, and the precision tube expander.

The electric expanding motor is designed to withstand continuous operating service with a minimum of attention. Complete with cable, it weighs approximately 7 lb. Through the control, the motor operates on 115 a-c, 60 cycle current. A special feature is the ball bearing stop collar which remains stationary when in contact with the tube end. It transmits thrust load to ball bearings in the housing to eliminate tube end cutting and frictional heating. Crane Packing Co.



MAY, 1949

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For This Boiler Room Piping, for example . . . as for any pressure or temperature condition . . . Crane offers an unequalled selection of valves, fittings, pipe and accessories. One catalog lists the entire line. One order to Crane results in fastest possible service. For Crane serves you through a network of well-stocked cooperating Branches and Wholesalers, also having direct access to large factory stocks.

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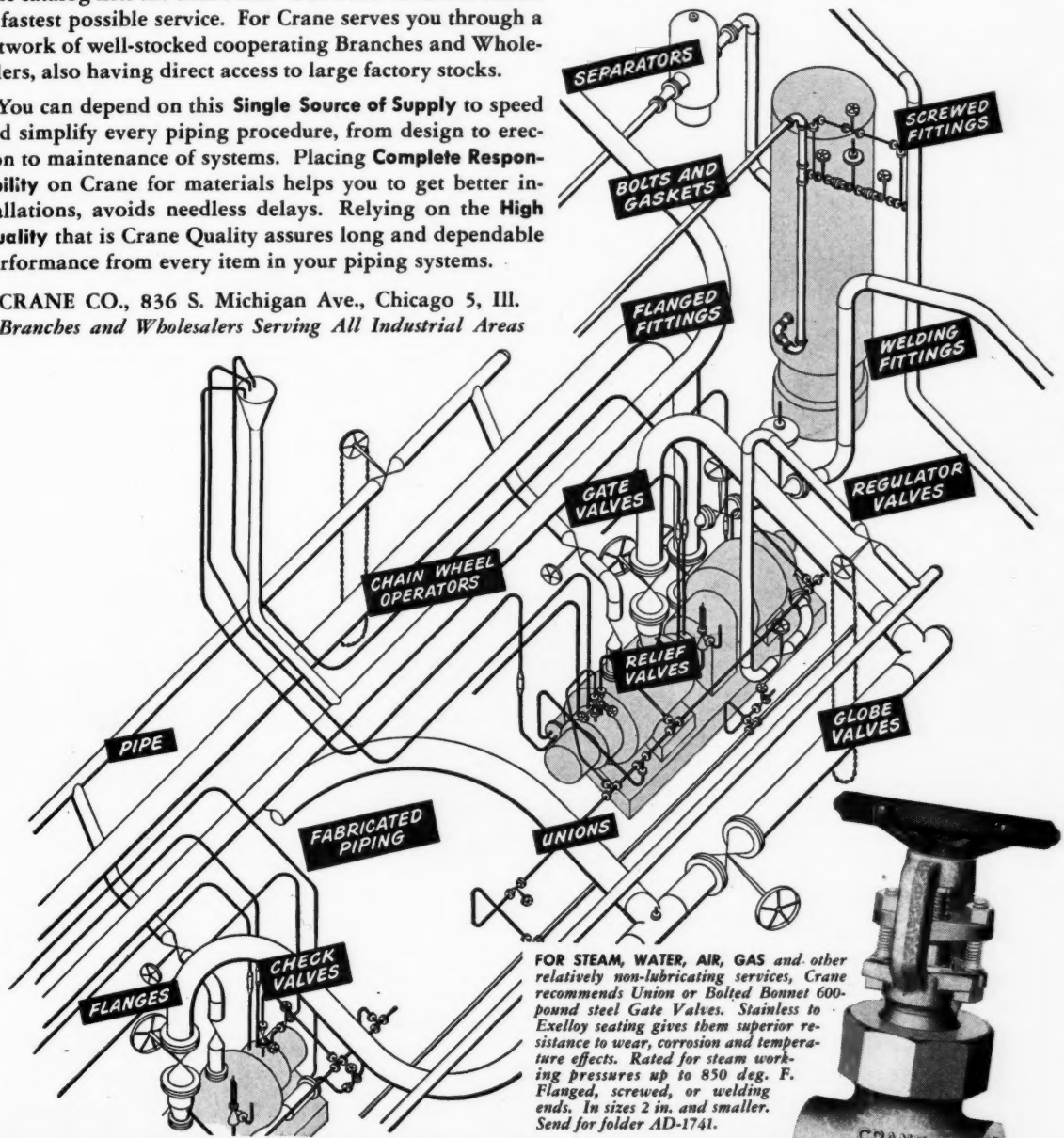

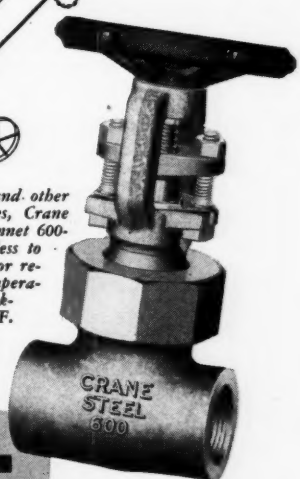

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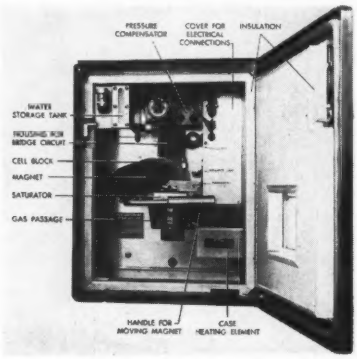
5—OXYGEN METER

Analyzes, indicates and records percentage of oxygen in gases

Operation of the oxygen meter, called the Magno-Therm, is based on the paramagnetic property of oxygen. It continuously analyzes, indicates and records percentage of oxygen in boiler flue and industrial gases. Gas enters through a cell block in which there are two cells with heated resistors. The sample gas diffuses into both cells. A strong magnetic field from a permanent magnet is directed across one resistor in measuring cells. The oxygen bearing gas is attracted into the magnetic field and is heated by the hot resistor. The oxygen loses its magnetism as it becomes heated and is forced out of the magnetic field by the cooler, more mag-



netic oxygen. The cooling effect on the heated resistor is proportional to the magnetism of gas entering the cell. This changes its electrical resistance and increases flow of current through it. This change in flow of current is compared with flow of current in comparison cell resistor (without magnetic field) and difference is measured by the Acratron electronic type recorder, calibrated to read in per cent oxygen.

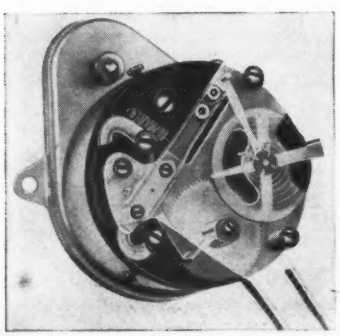
Measurement is compensated for ambient temperature, barometric pressure and variable moisture content of gas sampled. A safety factor claimed for this method is that temperature of analyzing cell is too low to support combustion. The presence of hydro-carbon gases and vapors doesn't affect accuracy of instrument, it is pointed out. The Hays Corp.

6—TIME-POWER SOURCE

Is built to combine accuracy of a clock with power of a motor

Series 5500 and 5700 d-c motors have a marine-type clock escapement governor which is simple in construction and said to be reliable in performance. It has the advantage of minimum size and weight, the manufacturer points out, and is unaffected by wide variations in voltage, load and temperature. It is designed to withstand vibration, gravity, fungus, humidity and corrosive atmospheres. These motors with jewelled escapement governor are said to maintain an accuracy of ± 1/10th of 1 per cent under variations of input voltage of ± 20 per cent, load variations from 0 to 30 in. oz. (based on 1 rpm speed) and over a temperature range of —50 F. to +150 F. The non-jewelled motors are designed to maintain an accuracy of +1 per cent under these conditions.

The timing motor is geared directly to a 180 deg cam which oscillates, causing control contacts in motor circuit to open. The unit stops with contacts closed, is self-starting and reversible. The A. W. Haydon Co.

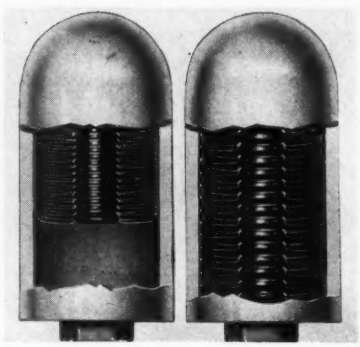


7—WATER HAMMER CHECK

Is developed to arrest damage caused by water hammer

A permanently sealed air chamber is said to eliminate damaging effects of water hammer and to require no servicing or maintenance after installation. It is designed to provide an air cushion to absorb the "water hammer" pressure impulse, and prevent water logging of the air chamber. A metal bellows allows free contraction and expansion of the air sealed within it but prevents all contact between air and water. Thus, the air chamber is continuously effective and provides constant protection against water hammer, according to manufacturer.

Advantages claimed for this water



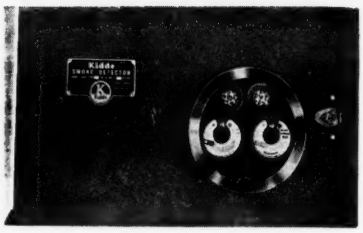
hammer arrestor include ease of installation and elimination of maintenance or servicing thereafter. It is recommended for guarding pumps, piping—particularly underground lead service pipes, and water-using machines against wear and strain caused by water hammer. Wade Manufacturing Co.

8—SMOKE DETECTOR

For early detection of incipient fires in hazardous areas

A single unit photoelectric smoke detector for early fire detection has been developed. In spaces where fires start slowly, smoulder, and produce smoke for some time before flames break out, photoelectric smoke detection equipment often betrays the presence of smoke before other alarms or devices are affected.

Smoke in the air sample cuts down the amount of light reaching the cell and sets off an alarm connected through an

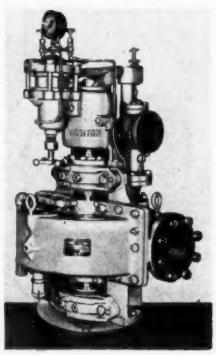


electrical circuit to a control panel. The control panel is the nerve center of the smoke detector. It transmits fire alarms, and gives warnings of mechanical and electrical disturbances within apparatus. This smoke detector is a useful adjunct to built-in carbon dioxide fire extinguishing systems, either automatically or manually operated, when smoke detector circuit is tied in with controls to operate ventilating dampers, door-closing releases, or electrical equipment power cut-off. Walter Kidde & Co., Inc.

9—VERTICAL TURBINE

For driving centrifugal pumps and other vertical units

Here's a small, compact, rugged vertical steam turbine capable of developing horsepower ratings up to 90 bhp. It is available in either semi-steel or cast steel to meet requirements of practically any steam pressures and temperatures.



This vertical turbine is equipped with both constant speed and emergency governors. Pump governors can be built into machine. Equipment also includes a bolting flange at the lower part of the casing to permit bolting to the flange of the driven unit. Whiton Machine Co.

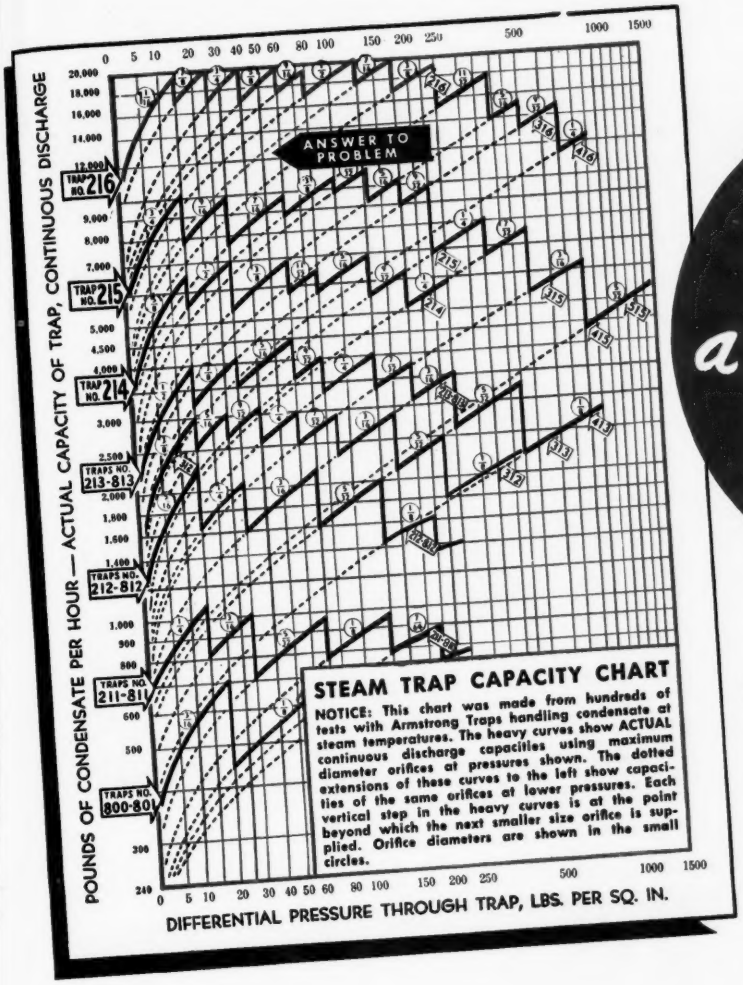
10—FLOW TUBE

For improving measurement, regulation and control of fluid flow

Conceived and designed in an effort to improve the measurement and control of fluid flow, a new flow tube, known as the Gentile (Gentilly) Flow Tube, has recently been placed on the market.

This tube consists essentially of a short length of pipe equipped with two groups of pressure nozzles around the inner periphery — one group pointing upstream, the other downstream. The nozzle groups are interconnected by common pressure rings.

According to the manufacturer, the flow tube is normally less than 1 pipe


ANSWER TO PROBLEM
TRAP NO. 216
TRAP NO. 215
TRAP NO. 214
TRAPS NO. 213-813
TRAPS NO. 212-812
TRAPS NO. 211-811
TRAPS NO. 800-801
POUNDS OF CONDENSATE PER HOUR — ACTUAL CAPACITY OF TRAP, CONTINUOUS DISCHARGE
DIFFERENTIAL PRESSURE THROUGH TRAP, LBS. PER SQ. IN.
STEAM TRAP CAPACITY CHART
NOTICE: This chart was made from hundreds of tests with Armstrong Traps handling condensate at steam temperatures. The heavy curves show ACTUAL continuous discharge capacities using maximum diameter orifices at pressures shown. The dotted extensions of these curves to the left show capacities of the same orifices at lower pressures. Each vertical step in the heavy curves is at the point beyond which the next smaller size orifice is supplied. Orifice diameters are shown in the small circles.

HOW TO SOLVE a Steam Trap PROBLEM:

BECAUSE good trapping starts with selection of the right trap for the job, Armstrong has provided all the data necessary for correct trap selection in the Armstrong Steam Trap Book. The Capacity Chart reproduced here is taken from this handy reference work. By means of this chart, any engineer can select the correct traps for his requirements. Here is a typical problem showing how the chart is used:

Given: An evaporator condensing 6000 lbs/hr at 50 psi when the steam is first turned on, but condensing only 1000 lbs/hr at 150 psi at the end of the process. Safety factor of 2 to 1 required at the *minimum* pressure differential.

Solution: Referring to the chart, the No. 216 Armstrong Trap with 7/16" orifice for 150 psi pressure has a capacity of 12,000 lbs/hr at 50 psi. This provides for the 2 to 1 safety factor and is, therefore, the correct trap for the job.

The Armstrong Steam Trap Book provides recommended safety factors for different services and handy tables to help you calculate condensing rates. Other useful data included are: hook-up diagrams; do's and don't's; trouble-shooting tips; prices and specifications. You're welcome to a copy. **ARMSTRONG MACHINE WORKS, 810 Maple Street, Three Rivers, Michigan.**

ARMSTRONG *Quality Backed* **STEAM TRAPS**

For fuel savings, low maintenance, automatic air removal SPECIFY ARMSTRONG!

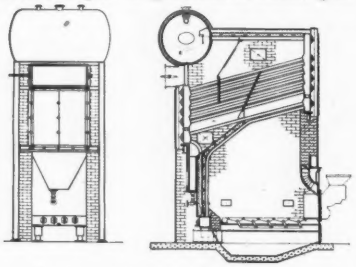
diameter in length and can be installed in any section of the pipe line with no straight run limitations. The differential produced is always a power of the velocity. Therefore, constant accuracy is claimed over the entire range of commercial flow measurement.

The manufacturer claims that these flow tubes can meter gases and vapors with the same facility as liquids. Bethlehem Foundry and Machine Co.

11—WATER TUBE BOILERS

With standard dimensions for various size units

A series of six new standardized water tube boilers in the Springfield Type M line is designed for coal firing with standard stokers, but can be adapted to oil or gas firing without major changes in installation. Sizes range from 7500 to 17,000 lb per hr guaranteed steam gen-



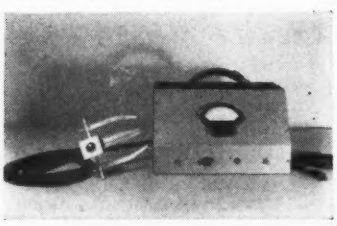
erating capacity with performance characteristics claimed to permit near straight-line operating efficiency over a wide load range.

Boilers are made with two standard tube lengths, 10 ft and 12 ft, expanded into sinuous electric steel sectional headers. Furnace width varies from 4 ft 7½ in. to 9 ft, depending on how many header sections are used. All boilers in line have 48 in. dia welded, X-rayed and stress-relieved steam drums built to pressure standards ranging from 160 to 320 psi. Overall setting height is 18 ft for all sizes. This type of boiler is for power, process, or heating service in small to medium size plants and for standby service in large plants. Springfield Boiler Co.

12—ARMATURE TESTER

For quick, easy indication and location of shorts in winding

This electronic bar-to-bar tester is a compact testing device designed for indicating and locating shorts in armature windings. Test unit has two essential sections: a vacuum tube oscillator which generates 3000-cycle a-c, voltage of about 15 v no load, and an electronic voltmeter with output impedance of 500,000 ohms to the vacuum tube amplifier. Tester does not have to be recalibrated when a tube is replaced, or require specially selected tubes for oscillator section, it is asserted. All tubes are popular types, easily supplied. Tester is mounted in a case. It weighs 23 lb and operates on a power supply of 110 v, 60 cycles a-c. National Electric Coil Co.



13—INSULATION TESTER

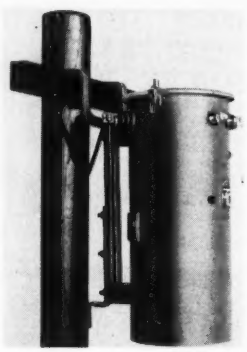
Can be supplied with 3 megohm ranges by range selector switch

"Standard" Megohmers have constant pressure, slip-clutch d-c generators, true cross coil ohmmeter movements with cobalt magnets. This type of movement is not dependent upon voltage as regards accuracy, manufacturer points out. Five different models are available with ranges up to 2000 megohms; test potentials of 500 v d-c and 1000 v d-c are available. Instruments are supplied with 12-ft rubber-covered, substantial test leads and a supply of megographs for recording insulation resistance measurements. Of compact design, built into a polished, hardwood case with hinged metal flap to protect scale glass. Weight ranges between 6 and 9 lb and dimensions between 5 x 5 x 8 in. and 5 x 5 x 10 in., depending upon model. Herman H. Sticht Co., Inc.

14—TRANSFORMER

Is dry-type distribution unit with air as cooling medium

The ability to withstand overloads claimed for the Type ACO transformer is credited to the use of heatproof insulation. The entire transformer element is seal protected against oil, acids, and moisture, according to manufacturer, and is housed in a sturdy, ventilated,



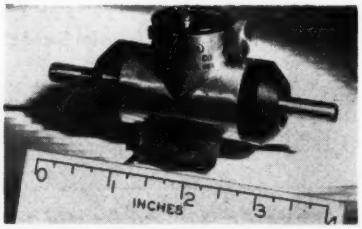
weather-proof case conforming with EEI-NEMA construction standards. This transformer can be used outdoors, pole or platform mounted, or indoors at the load center, mounted wherever convenient. While suitable for practically all applications where a distribution transformer is required, these units are especially recommended for use in hazardous locations. Available in sizes to 100 kva, voltages to 5000 v. Marcus Transformer Co., Inc.

15—SPEED CHANGER

Is packaged unit, designed for variable ratio speed adjustment

The Metron Miniature Variable-Ratio Speed Changer, a small packaged unit, weighs less than 6 oz., yet it can deliver up to 70 in.-oz. torque and 0.025 hp. Ratio of input to output speeds is adjustable between 1:6 increase and 6:1 decrease, with a total speed range of 36 to 1. A dial and pointer indicate ratio setting and the adjusting knob is equipped with friction drag to prevent ratio wander. Efficiency, speed regulation and no-load loss characteristics are said to be good. Maximum output torque is obtainable at zero speed and operating speeds as high as 30,000 rpm are considered practical.

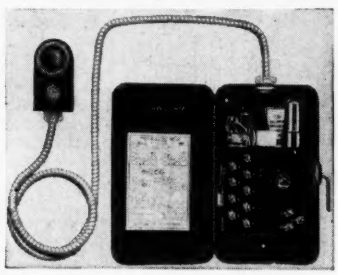
This variable unit complements Metron Fixed-Ratio Speed Changer, having same body diameter, mounting foot, and shaft height over mounting surface. Unit can be driven by any speed motor. Metron Instrument Co.



16—PHOTOELECTRIC CONTROL

Is built for wide industrial and machinery application

Photoswitch Type 20DJ provides automatic control for specialized industrial processes, counting, conveyor control, short range signal systems, motor or valve control, machinery safeguards and stop-motion control, as well as



safety alarms and door operator services. Adaptable where space is limited. Phototube must be located where operations are controlled; comes integral with housing or in small separate housing. Tamper-proof sensitivity adjustment permits operation over varying distances between tube and light source.

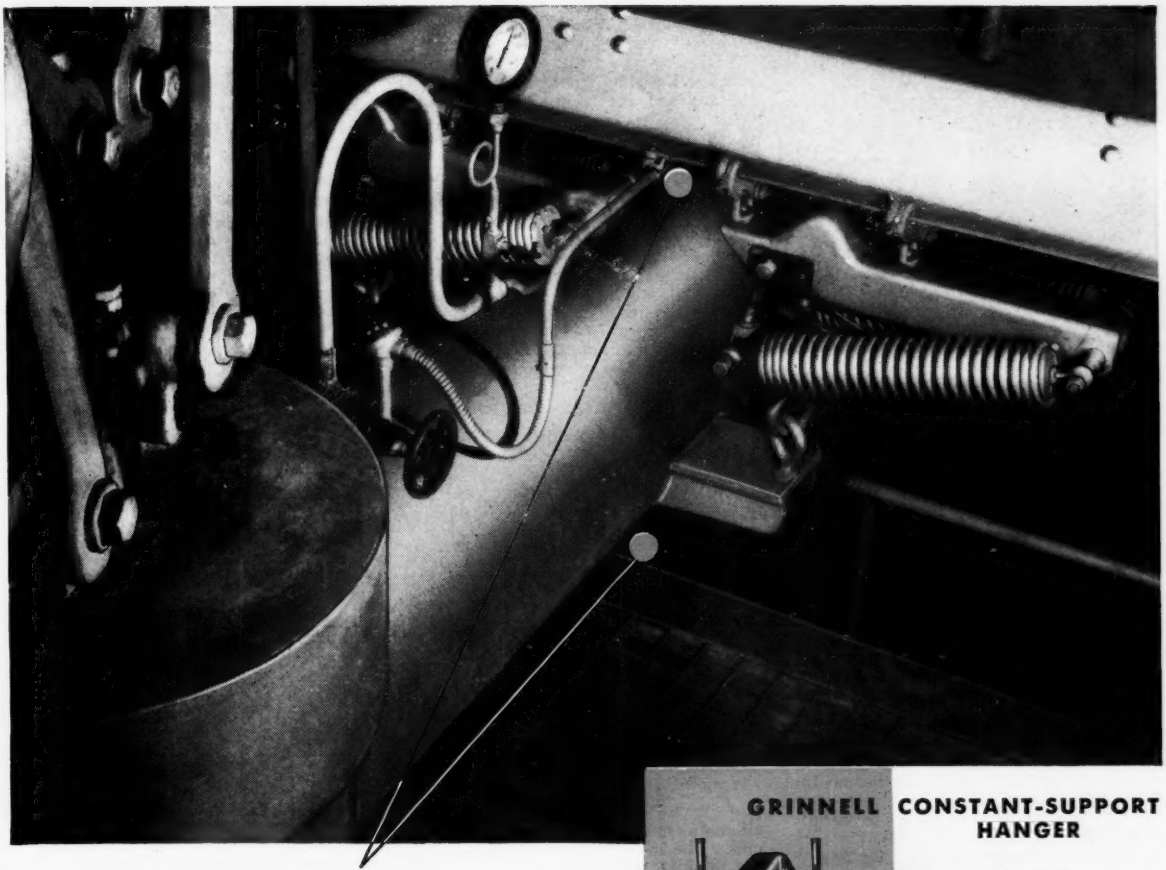
Control is designed for high speed operation; relay operates in 1/20th of a second. Has 10-ft operating range. Provides for relay operation at any predetermined level of illumination within range of 10 to 50 ft-c. May be used with 115 or 230 v 50-60 cycles a-c supply; double-pole, double-throw relay; pure silver contacts. Maximum rating: 10 A, 115 v, and 5 A, 230 v a-c, non-inductive ½ hp, 115/230 v a-c with both poles wired in parallel. Photoswitch Inc.

17—IMPACT WRENCH

Helps get heavy equipment back into service quickly

This new large-capacity air impact wrench was developed to reduce the time required for repairs and ease the manual load on workmen. Known as the Size 577 Impact Wrench, it is designed to handle large studs, bolts, nuts, and cap screws from 1¼ up to 2 in. thread size. It operates on the rotary impact principle, by which motor torque is converted into 1000 powerful rotary impact blows per minute.

It furnishes power for heavy work, although it weighs only 72 lb (less socket) due to extensive use of magnesium in housings. Length to shoulder of square driver is 24½ in.; rated capacity, 2 in. bolt size; size of square drive, across flats, 1½ in., and free speed 535 to 565 rpm. Ingersoll-Rand Co.



PLAYROOM for a HEAVYWEIGHT

It's a lively chunk of deadweight, this big boiler lead from a superheater outlet at the stop and check valve . . . in the new Southwark station of the Philadelphia Electric Company. It requires "playroom". From its position when cold to its position at 900°F., this piping travels through all three planes — vertical, lateral and longitudinal.

At every point of its travel, the weight of this piping is fully supported by Grinnell Constant-Support Hangers. Yet, because of their compact design, little extra "playroom" need be allowed in which to install the hangers.

Write for the new Grinnell Pipe Hanger Catalog 10-D, containing every pipe hanger, part and accessory, with full instructions for easy selection and correct specification.

GRINNELL CONSTANT-SUPPORT HANGER

the ONLY constant-support pipe hanger

- provides constant support to piping subject to vertical movement—in all "hot" and "cold" positions.
- maintains full safety factor in supporting high temperature, high pressure piping.
- non-resonant and energy absorbing.
- mass-produced from standard precision parts.
- individually calibrated for each installation.
- load-adjustment features incorporated into design.
- three models meet entire range of load-travel specifications.
- minimum headroom required.

99 YEARS PIPING

GRINNELL

Grinnell Company, Inc., Providence, R. I. Branch warehouses: Atlanta • Buffalo • Charlotte • Chicago • Cleveland • Cranston • Fresno • Kansas City • Houston Long Beach • Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

18—AUTOMATIC AIR VALVES

For hot water heating, they help prevent fuel waste

According to the manufacturer, the new automatic hot water air valve, called Taco-Vent, requires no adjustment and no manual venting; it conserves fuel by keeping radiator rid of air and filled with hot water. Its operation is described thus: Air passes through its special filter, porous bronze plug, fiber discs and vent holes to atmosphere; water following the air is cleaned of foreign matter and "slowed up" as it passes through bronze plug. When water reaches the fiber disc it causes it to swell, thus sealing the valve. As more air accumulates the disc dries and shrinks, permitting valve to vent again. This valve is recommended for use on radiators, radiant baseboards, convectors and high points. Taco Heaters, Inc.

19—CURRENT LIMITER

For protection against damage by short circuit currents

The Amp-Trap is described as a lightning-fast current limiting device of high interrupting ability for protection on low voltage circuits. It is designed to protect metal clad switchgear, busducts, circuit breakers, fuses and current transformers against damage by short circuit currents. It's supplied in all ampere sizes from ¼ to 4000 amp, for a-c circuits up to 600 v and d-c circuits up to 750 v. It's built with overload elements. It can also be used as a disconnecting device.

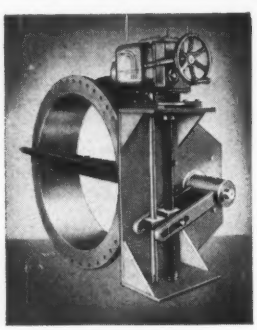
The Amp-Trap works by limiting the development of short circuit current to a low value. It is designed to handle short circuits where the available current may reach 200,000 amp. It doesn't interrupt 200,000 amp, but it stops or limits build-up of short circuit current before current can develop greater magnitude, according to the manufacturer.

The Amp-Trap may be installed in new or old systems, and is also applicable in enclosed safety switches. The Chase-Shawmut Co.

20—50-LB IRON VALVE

For hydraulic service, controlling flow of condenser water

A 54-in., 50-lb iron valve of rugged construction, this has 125-lb American Standard flanges and is operated by a limitorque electric motor connected to a threaded reach rod that moves the valve slowly to prevent water hammer.

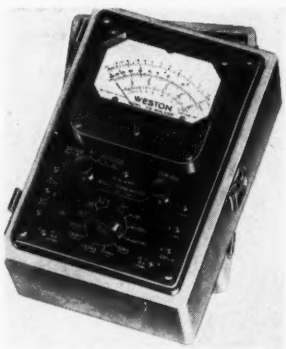


Threads on the reach rod can be cut for a large variety of speeds ranging from 60 sec to 8 min. This type valve is also available in larger sizes for higher pressures and in materials other than iron. Wedge-type closure is by vane or disc. Valve can be fitted with renewable and replaceable rubber spool designed for positive shut-off, said to provide bubble-tight shut-off up to 80 psi air and commercially tight shut-off up to psi water. R. S. Products Corp.

21—ANALYZER

Is designed for maintenance of low level speech circuits

A new Weston analyzer, designed specifically for communication system maintenance — telephone, carrier current, and transmission line measurements—is listed as the Model 779, Type 5. It measures low level speech circuits with a minimum of disturbance. It is described as self-contained, requiring no power line connection. This analyzer makes dbm readings at



all audio and carrier current frequencies. The a-c response is essentially flat to 50 kc within 1 db over the range -20 to +22 dbm, and is usable for comparative db readings on all common carrier current frequencies above 50 kc.

The 1-v a-c range has an impedance of 2500 ohms, permitting its use as a bridging device with a minimum effect on relays and other line equipment components. In addition, a 600-ohm switching circuit converts the analyzer to a terminating db meter. Unit has complete ranges to 1000-v a-c and d-c, d-c current from 100 microamp to 10 amp, and resistance ranges from 1000 ohms to 10 megohms, along with a transmission measuring instrument calibrated in ½-db steps. Weston Electrical Instrument Corp.

22—FHP MOTORS

Unit bearing, shaded pole type, for use on portable equipment

Designated as the Type KSP71, these new motors are available in these ratings: 1/40 hp, 60/50 cycle, totally enclosed; 1/25 hp, 60 cycle, totally enclosed; and 1/15 hp, 60 cycle, open. All ratings are available for 115 v or 230 v and for CW or CCW rotation. Suitable for use as drives for fans, blowers, and small pumps, the new motors have a die cast aluminum frame, with a resultant weight reduction. Each rating can be used for horizontal or vertical shaft up operation; each can be obtained with identical outline features. The new models are available in shaft-end, opposite shaft-end, and resilient-base mountings. The motors may also be band-mounted; a space 1-3/32 in. wide around the center of the stator is available for this type of mounting. Fractional Horsepower Motor Div., General Electric Co.

23—SEPARATOR

For "spot" installation on compressed air lines to remove moisture, dirt

Designated "Murphy Paragon C," this separator is designed to remove the last trace of oil, moisture and dirt from compressed air at point of use. Installed in pipe line just ahead of point of delivery, air enters the units at the top right and is conducted to the expansion chamber below the strainer cartridge, where expansion and surface contact separates air and moisture. The air then rises slowly through two cotton felt absorbent pads, tightly packed between perforated brass baffles in the filter cartridge. The pads are to trap any oil, grit and moisture.

In two sizes, No. 1 measures 5¼ by 8½ in. overall, accommodates inlet and outlet pipes sizes of ⅛ to ⅜ in., delivers to one ⅛ in. pipe nozzle only and sells for $28.00. Size No. 2 measures 6½ by 8½ in. over-all, accommodates pipe sizes of ⅛ to ¾ in., delivers by manifold to four ⅛ in. pipe nozzles or to two ¼ in. pipe nozzles and sells for $39.00. James A. Murphy & Co.

24—SILENT PAGING SYSTEM

Pages with circle of lights arranged like numbers on a clock

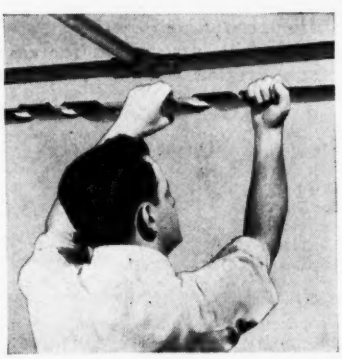
The Visicall system functions on the premise that anyone can tell time from a clock by "position" of numbers, without the numbers themselves being visible. Its call station is a 2 x 2 ft board with lights in a circle, in positions corresponding to numbers on a clock. Each person subject to call has a number. If it's 3, he answers when the light in the "3" position flashes on the call board. If more than 12 persons are on a call system, additional circles of lights are used, each circle being a different color. As many as 48 persons can be signalled by using 4 circles.

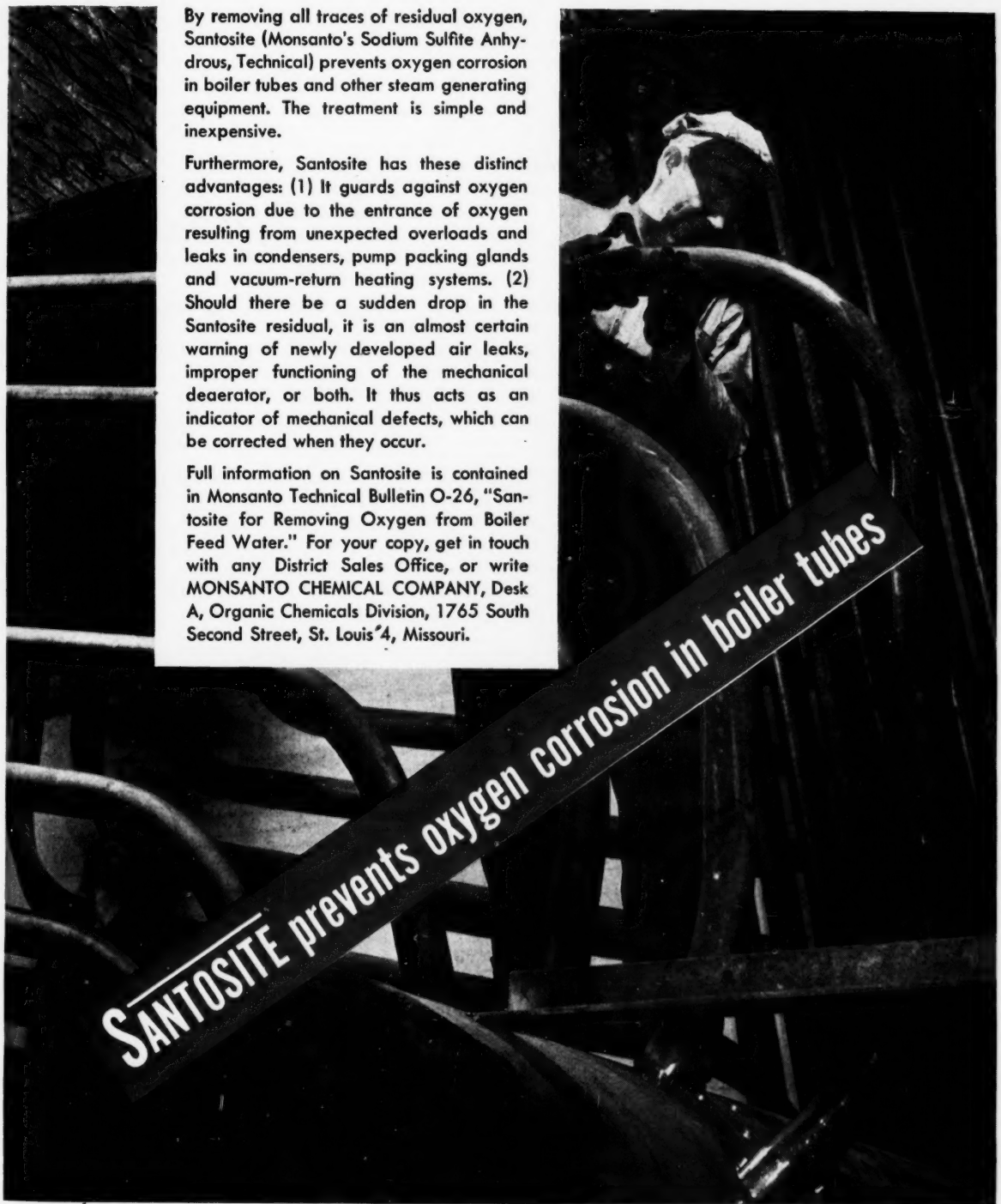
Features claimed are low-cost wiring, use of low-wattage bulbs and light gage wire, low upkeep, and the need for few light stations. Installation requires two common wires and a return wire for each call signal (a 12-call system takes 14 wires), plus an extra pair of wires if audible signal is used. Systems can be operated on a 24-v transformer. The H. R. Kirkland Co.

25—CORK FILLED TAPE

Is easily wound on cold water pipes to stop condensation drip

The improved cork-filled NoDrip Tape is said to be more pliable than formerly and much easier to put on cold water pipes. Sections classed as dead because of constant condensation drip from overhead water pipes can be turned into storage space or work





By removing all traces of residual oxygen, Santosite (Monsanto's Sodium Sulfite Anhydrous, Technical) prevents oxygen corrosion in boiler tubes and other steam generating equipment. The treatment is simple and inexpensive.

Furthermore, Santosite has these distinct advantages: (1) It guards against oxygen corrosion due to the entrance of oxygen resulting from unexpected overloads and leaks in condensers, pump packing glands and vacuum-return heating systems. (2) Should there be a sudden drop in the Santosite residual, it is an almost certain warning of newly developed air leaks, improper functioning of the mechanical deaerator, or both. It thus acts as an indicator of mechanical defects, which can be corrected when they occur.

Full information on Santosite is contained in Monsanto Technical Bulletin O-26, "Santosite for Removing Oxygen from Boiler Feed Water." For your copy, get in touch with any District Sales Office, or write MONSANTO CHEMICAL COMPANY, Desk A, Organic Chemicals Division, 1765 South Second Street, St. Louis 4, Missouri.

District Sales Offices: New York, Chicago, Philadelphia, Boston, Cleveland, Detroit, Charlotte, Birmingham, Houston, Los Angeles, San Francisco, Seattle, Portland. In Canada: Monsanto (Canada) Limited, Montreal.

Santosite: Reg. U. S. Pat. Off.

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Name_____ Title_____

Company_____

Address_____

City_____ State_____

SERVING INDUSTRY . . . WHICH SERVES MANKIND

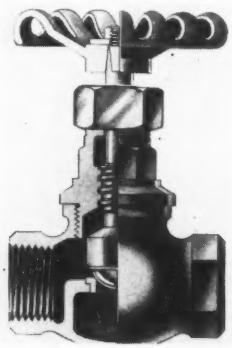
rooms by winding this tape around the pipes, it is said.

NoDrip Tape is clean and relatively inexpensive. Straight pipes, valves, joints and tees can be covered by anyone in a few minutes without use of tools, adhesives or brads. Before applying, pipes are wiped dry and then NoDrip Tape is wound spirally around them to form a tight-fitting, sealed jacket. NoDrip Tape is brown, but can be painted any color with cold water paint. Enough to cover about 10 ft of ½ in. pipe comes in the standard $1.69 package. J. W. Mortell Co.

26—BALL VALVE

Is made with stainless steel ball as seating member

The "Bull Dog" valve utilizes a precision ground stainless steel ball to effect a lifetime seating member with harmless effect upon the seat. The ball is spun into its retainer, allowing a slight clearance, which permits ball to spin when valve is opened or closed, thus



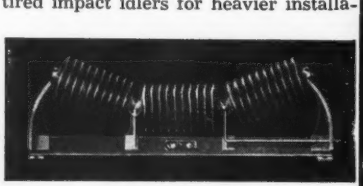
permitting ball to find a new seat each time, according to manufacturer, who adds that care is used to hold ball clearance accurately to prevent chatter when opening, closing or throttling.

This ball valve is supplied with "O" ring seals, for normal service where high temperature is not involved. Conventional steam packing is used in valves installed in steam or other high temperature service. Improved flow characteristics are said to be a natural result of the shape of the ball. Now available in ½ and ¾ in. pipe sizes, in brass, for 300 lb water, oil, or gas pressure. Carpenter Mfg. Corp.

27—IMPACT IDLERS

Are made for use with flat, troughed or return belts

These Rubber Disc Impact Idlers are interchangeable with practically all standard idlers now on the market. Their construction has same features embodied in manufacturer's standard idlers. The use of impact idlers under the loading points is claimed to materially reduce damage to the cover and carcass of the belt. When damage is minimized, the cost per ton of material handled is naturally reduced. Also available are hollow-center rubber tired impact idlers for heavier installations, as well as special impact idlers to meet specific conditions. All of these idlers are equipped with anti-friction bearings. Industrial Div., Continental Gin Co.



28—MAGNETIC PULLEYS

For extracting tramp metals before or during processing

Power-Plus "non-electric" permanent magnetic pulleys require no outside power source. They can be used as either head end or idler pulleys in belt conveyor systems and are designed for use in industries requiring thorough tramp metal extraction in their processing operations.

These pulleys come in 57 standard sizes, including diameters from 12 to 30 in., and belt widths from 4 to 60 in. They are crowned to prevent belt weaving and runout and to assist in equalizing conveyed material as it passes over pulley. Standard or special length shafts fit new or existing applications without changing bearings or shaft mountings. Head plates are cast aluminum. There's said to be no loss of magnetic flux to the shaft. According to manufacturer, pulleys are not affected by atmospheric or temperature changes and can be applied to either indoor or outdoor applications. The Homer Mfg. Co.

29—VIBRATING SCREENS

Are designed for economical and efficient rough sizing

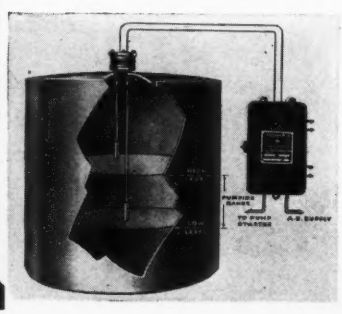
A new line of vibrating screens are made with stepped, punched plates having tapered elongated openings—the size of the latter depending on material specifications. Single or multiple deck screen plates are available as desired. Screen area is activated by manufacturer's "Vibra-Flow" vibrating motor featuring variable control of material flow. This provides a two-purpose unit, a vibrating screen and a rheostat controlled vibratory feeder designed to increase efficiency and capacity of crushers and fine grinders and to prevent damage to belt conveyors by allowing the fines to cushion the lumps. Syntron Co.

30—LIQUID LEVEL CONTROL

For use with all electrically conductive liquids

In the Series 10 Liquid Level Control contact with the liquid is made only through stainless steel probe rods. The control consists of an electrical relay operating from a probe circuit through a transformer and a rectifier.

Two probe rods, wired to control, project into tank to levels corresponding to low point where pumping is to start and high point at which pumping stops. When liquid level in tank falls below lower probe, the level control closes the electrical circuit controlling pump or valve. When liquid rises to level of upper probe, the fluid acts as a conductor of the minute current at low voltage required for operation of relay and the central circuit opens. Operates on 115 or 230 v, 50/60 cycle a-c supply; total power consumption ½ w. Single-pole, double throw relay. Contacts, 2 amp at 115 v and 1 amp at 230 v. Designed for motor starter, motorized or solenoid valve operation. Arc suppression is supplied on both contacts. Probe circuit will operate from a resistance as high as 3500 ohms. Photoswitch Inc.



31—FUEL OIL TREATMENT

Is designed for use in oil-fired boiler furnaces to curb sludge, gumming

Nalco SR-155 is intended to prevent sludge formation in storage tanks, eliminate fouling of fuel-oil preheaters, stop gumming at burner tips, and remove soot in the combustion chamber and flues. It is added to the fuel oil in the storage tank and requires no special feeding equipment. Extensive testing in power plants is said to show that use of Nalco SR-155 can result in substantial time and fuel savings where sludge, gumming or soot conditions are present. National Aluminate Corp.

32—STEEL DRAWER CABINETS

For small parts; may be used singly or in groups

Two new sturdy, low priced steel drawer cabinets are designed especially for nuts, bolts, washers, screws, nails, plumbing and hardware supplies, electrical parts, and other small pieces. They can be used singly, side-by-side, back-to-back and stacked on top of each other. Frames are welded into one strong solid assembly. Drawers have adjustable cross dividers. Lengthwise dividers may be added or removed. Label holders are furnished for every drawer or divider. Finished in olive green baked enamel.

Equipto No. 11 has 18 drawers, each with 3 cross dividers, giving 72 adjustable compartments. The overall width is 34 in., height 13¾ in., depth 12 in. It sells for $24.50. Equipto No. 8 has 8 drawers, each with 2 cross dividers (24 compartments). Its overall width is 25½ in., height 10 in., depth 12 in. Drawer size is same as the No. 11. It sells for $11.50. Aurora Equipto Co.

33—INDICATING PYROMETER

For measuring temperatures in kilns and furnaces

These pyrometer indicators have dials calibrated in both Fahrenheit and Centigrade. Scales are over 3 in. long. Meter case measures 3¾ in. wide and 3⅜ in. high has one-piece clear plastic front. Ideal for measuring temperature in ceramic kilns, as well as furnaces and ovens and baths, these pyrometers come in rangese for heat up to 2500F and 1370C.

Four ohms per millivolt gives a high resistance of 212 ohms for 2500F. Thermocouples don't need calibrated leads. Meters are calibrated for 10 ohms external resistance (8 ohms for 500 deg range). A suitable resistance spool, connected in the thermocouple circuit is brought out to an extra terminal on the back of the meter. With this in the circuit thermocouples with uncalibrated leads up to 15 ft long are used. Assembly Products, Inc.

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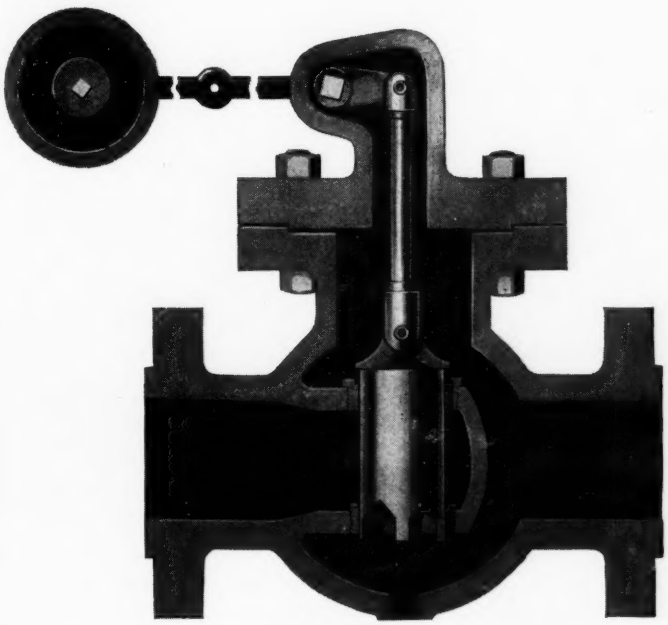

A valve may be statically balanced while at rest, yet be so badly unbalanced dynamically—when handling flows under pressure—that inaccurate response to the actuating element causes a "hunting" action which makes impossible the desired precision of control. In COPES Valves, unbalanced forces are held within narrow limits over the entire operating range. This is why so many have been purchased *at a premium,* where control must be precise with actuation by float, solenoid or other element. Sizes: ¾-inch and up. When writing for data, give complete information on your operating needs.

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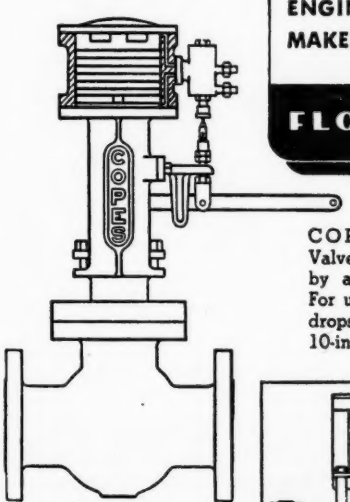
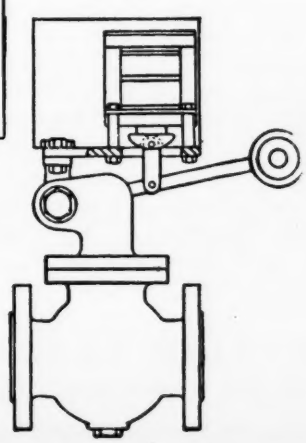


COPES Type SLH Valve, relay operated by air, oil or water. For unlimited pressure drops. Sizes: 1½- t 10-inch.



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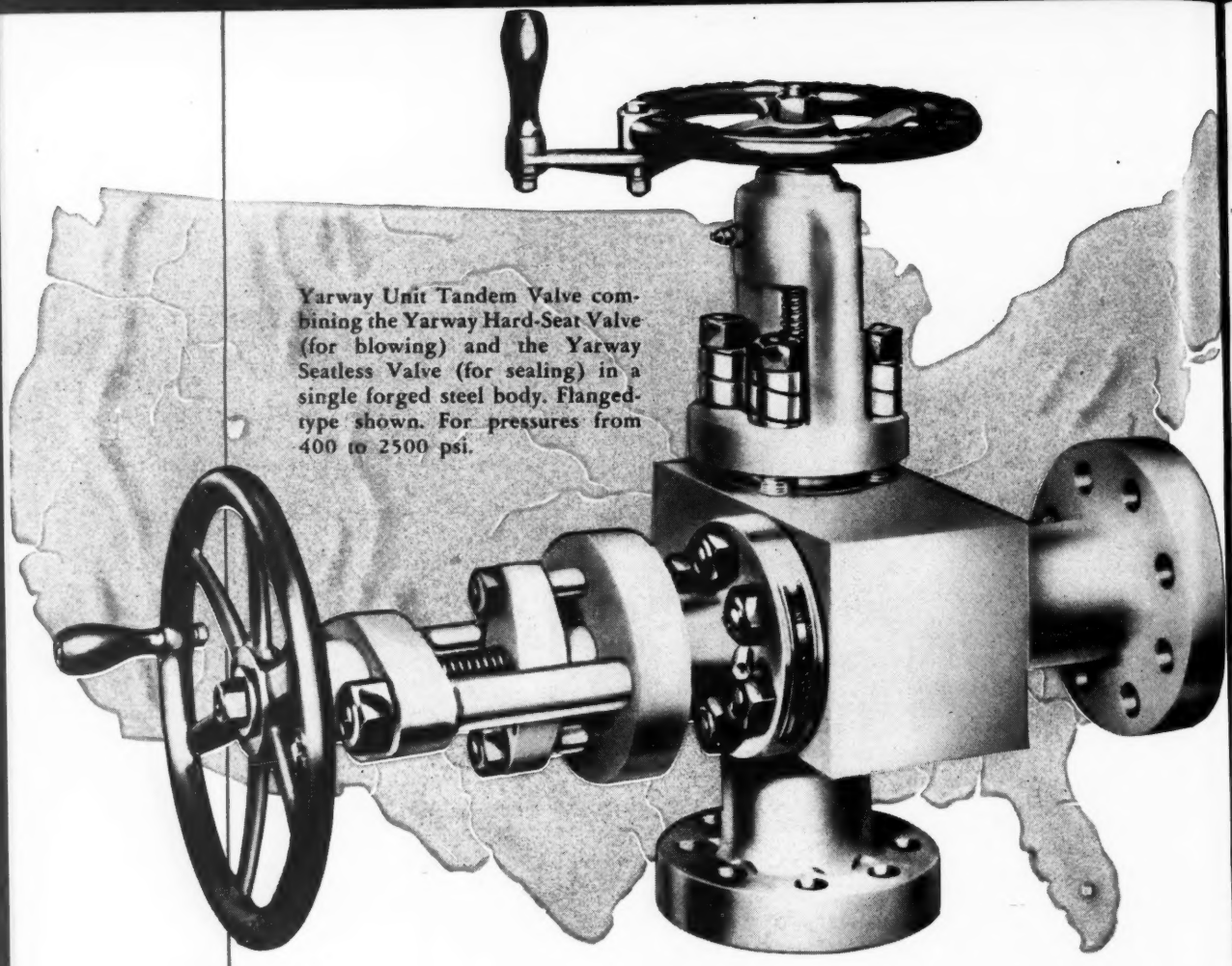

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LETTERS TO THE EDITORS

METALLURGY

THE DISCUSSION of sharpening tools by John G. Reynolds, January issue, and the comments about copper alloy tools by Wm. J. Harding, March issue, bring out the fact that every engineer today must know something about metallurgy.

This point has been forcibly brought home to power engineers during the past twenty-five years. They have seen very clearly how developments in metallurgy have permitted them to carry out a great many engineering ideas discussed years ago, but not possible at that time because proper materials could not be obtained.

The classic example of this, now well understood by most engineers, is of course the gas turbine. Its fundamental principle goes back some two thousand years to the famous turbine of Hero of Alexandria. John Barber, in 1791, was granted a British patent on a gas turbine. In the great "bible" of the turbine field, Steam and Gas Turbines, by Dr. A. Stodola, Section XI is devoted entirely to analysis of the theory and performance of the gas turbine; yet it was not until the development of axial flow and centrifugal compressors of high efficiency, and, more important, the development of metals that could withstand high temperatures, that it became possible to build practical gas turbines.

Another well known example of the way in which metallurgy affects power development is in the entire subject of graphitization of power plant piping at temperatures above 900 F.

Still further, many power engineers remember how, thirty-five years ago, the work of the oil refineries in raising process pressures and temperatures led to the development of piping and valves capable of withstanding pressures and temperatures up to 1450 psi and 900 F. This showed that it was possible to handle such conditions and, in turn, the power industry was encouraged to raise temperatures and pressures, since equipment could be manufactured for them.

Another typical way in which the power engineer must be concerned with metallurgical developments is illustrated by the Kelcaloy joint, page 121, January issue, POWER GENERATION. In this case, at the Sewaren Generating Station, the first 1050-F plant to go into operation, it was necessary to join a ferritic chrome molybdenum pipe leading from the superheater of the steam generating unit to an austenitic steel valve and inlet steam piping at the turbine. To join these dissimilar metals, a special joint had to be developed and fabricated in such a way that each metal could be welded to a similar metal on either end of the joint, and the metals would change from one to the other inside the joint.

Development of the engineering phases of nuclear energy power plants, as A. W. Krämer, your editor, has often shown, depend largely on development and use of metals to fit these new conditions. These are now being investigated.

It is very encouraging and significant that many of the engineering colleges are beginning to make their students aware of this importance of metallurgy in much the same way as practicing engineers are aware of it. In the *Journal of Engineering Education*, December 1948, John Shipman of M.I.T. presents a discussion of metallurgy and its place in engineering education. Again, in the January 1949 issue of the *Journal*, A. G. Guy of North Carolina State College points out a very important factor in teaching metallurgy to mechanical engineers: That present metallurgical practice and theory are dynamic rather than static.

For that reason, he says, a student of mechanical engineering should be given, first, acquaintance with the voluminous information on current metallurgical practice and second, should be given adequate preparation for further education in metallurgy. To do this, he must be made to understand that much of what he learns in college is of a very temporary character and that he must keep up to date on it every minute, all the rest of the time he is practicing engineering. A second factor in enabling him to do this is an acquaintance with the varied literature of the field and a third is considerable background knowledge.

All this applies particularly to power engineering, as the above examples illustrate.

Chicago, Ill. E. C. REED

WATER SHORTAGE

THE RECENT AND prospective droughts in California seem to have been the signal for well-meaning but ill-informed persons to come forward with schemes more or less fantastic for augmenting the existing water supply. These schemes range from bringing down water from the Columbia River to the evaporation and distillation of sewage and sea water by means of atomic energy. According to the newspapers of last year, a writer, described as a "steam plant engineer" wrote to the Board of Supervisors and to the Mayor that, "Existing steam generating plants along the Los Angeles County coast line could produce 100,000,000 gal of pure water daily from sea water at very little cost." Also, ". . .valuable chemicals obtained as an auxiliary by-product would help pay for the small additional fuel costs required to do this job." In a recent statement to the Board of Supervisors, this man asserted that a "pilot plant" " . . . could make fresh water from salt water at a cost of $17.50 an acre-foot as compared to the present cost of Colorado River water, which costs about $22 an acre-foot after sanitation treatment." This man evidently had in mind the use of multiple-effect evaporators using exhaust steam.

Naturally, the steam plants alluded to would have to be within pumping distance of the ocean, which practically limits the plants to the large central stations of which there are four in this area, but which are rather widely scattered. Because of these conditions there would not be one large evaporator plant, but one at each of the four large steam plants mentioned.

An output of 100,000,000 gal of water a day is nearly 70,000 gal a minute; which might seem like the required capacity of the plants. But the demand for water is not constant over the 24 hr of the day, so the nominal capacities of the plants would have to be trebled, or a system of reservoirs established. If the reservoir system is adopted, there must be a low-pressure pumping plant to deliver pure water to the reservoirs, and a high-pressure plant to pump it into the city mains. If the total daily output is divided equally between the four plants, the capacity of each would be 25,000,000 gal a day. With a velocity of 6 fps, the size of the main receiving this water would be nearly 36 in. At the same velocity, a single main receiving the outputs of the four plants would be nearly 72 in. There being no such mains in the localities, they would have to be installed by the usual method of tearing up many miles of city streets. These four plants pumping 100,000,000 gpd of water through the 20-odd miles system to Los Angeles, plus the reservoirs and the piping system, cannot be had at "small cost."

Successful operation of sea-water evaporators necessitates a so-called blow-down to reduce the salinity of the brine in the evaporators. This blow-down about equals the amount of distillate produced; that is, for every gallon of distillate produced there is pumped into the evaporator

(Continued on page 80)

Staley Expand Power Plant at Decatur

New 125,000-lb-per-hr, 400-psi, 700-F boiler, fired by traveling grate stoker, increases capacity to meet growing process demands of A. E. Staley Mfg. Co., Decatur, Ill. . . . Part of long-range program for increasing steam and power generating facilities . . . New 2500-kw turbine installed on existing generator . . . Electrical distribution system being expanded to provide 13,800-v switchgear and underground power feeders for section of plant area . . . Part of the required power will be purchased

Fig. 1. View looking down firing aisle of Staley power plant, in front of existing boilers, with new boiler No. 19 in right foreground

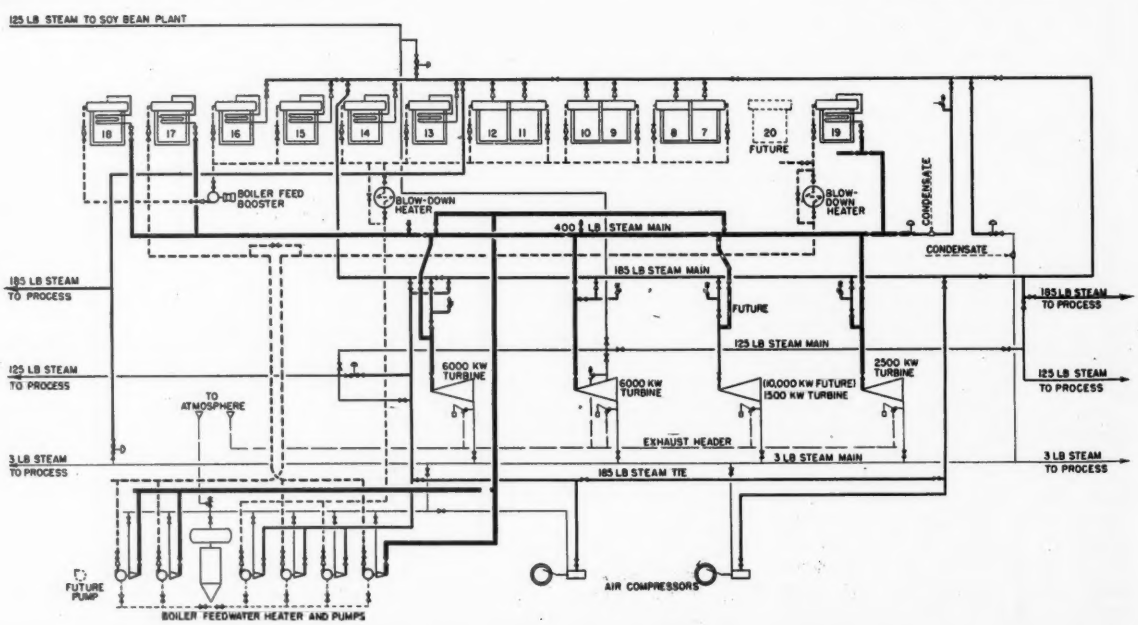


Fig. 2. Staley power plant steam flow diagram. New 125,000-lb-per-hr, 400-psi boiler is No. 19. Provisions made for replacing 1500-kw unit with 10,000-kw high-pressure unit in future

CHANGES and additions which will increase the capacity of present power plant and distribution systems by 21 per cent and allow for an ultimate 70 percent increase are under way at A. E. Staley Manufacturing Co., Decatur, Ill. These changes are a part of this corn and soybean processing firm's $11,500,000 plant modernization and expansion program.

When completed, additions and improvements in power plant facilities will enable the plant to generate and distribute 17,000,000 lb. of steam per day and carry a peak electrical load of 14,500 kw (an electric power capacity, incidentally, about equal to the normal requirements of many communities with populations of 70,000 or more).

The increase in power plant facilities was needed to handle growing demands of existing plant units and to provide power for the new glutamate building, pilot plant, feed packing house, machine shops and new service facilities such as the safety and first aid building.

To accommodate a new 125,000 lb.-per-hr., 400-psi, stoker-fired boiler, a portion of the boiler house has been completely rebuilt and enlarged. The new addition is 52 ft. long, 51 ft. wide and 94 ft. high from the basement to the roof line. On top of the addition is a new 165-ft., gunite lined, self-supporting steel stack, 9 ft. in diameter. The stack is capable of handling an additional 125,000-lb-per-hr unit.

The new boiler, fitted with a travelling grate stoker, as shown in Figs. 1 and 7, brings to 13 the number of boilers in Staley's power

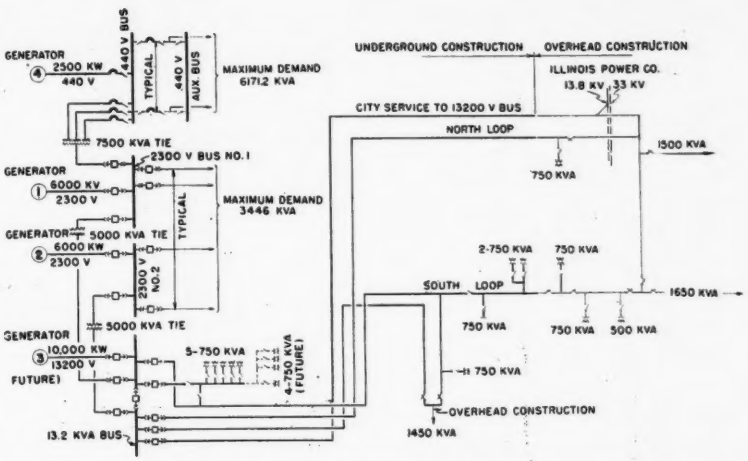


Fig. 3. One-line electrical diagram of electrical distribution system at Staley plant

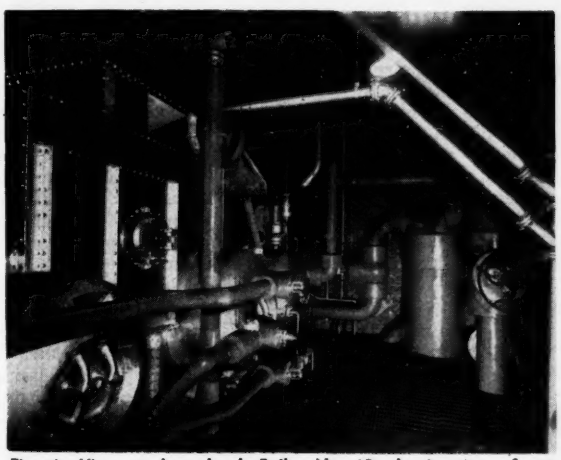


Fig. 4. View at drum level, Boiler No. 19, showing top of one of feedwater heaters

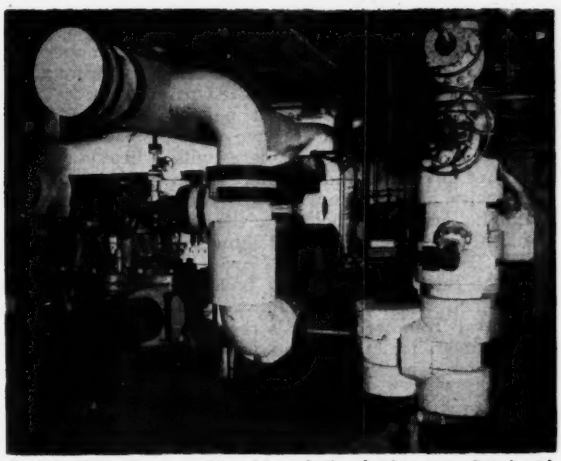


Fig. 5. One of new turbine-driven boiler feed pumps, fitted with automatic throw-over device to start stand-by pump

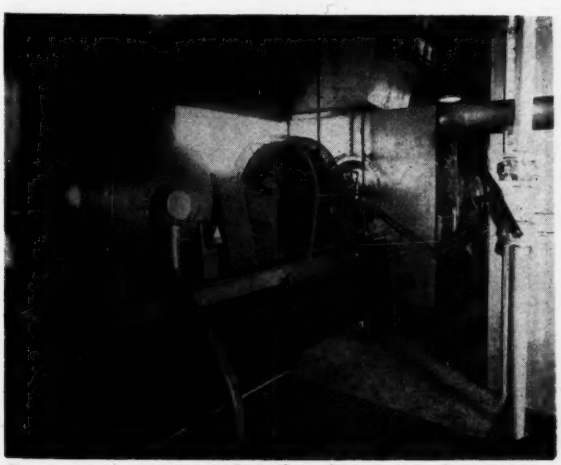
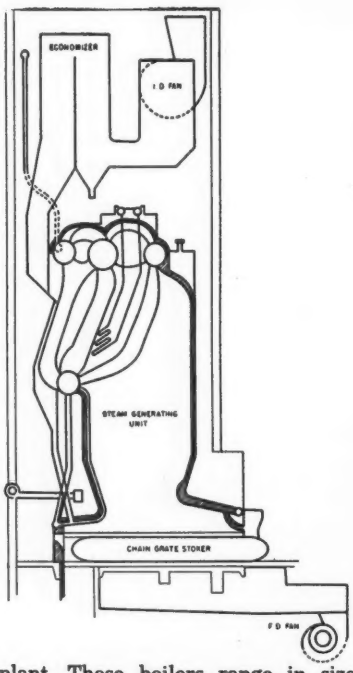


Fig. 6. View of induced draft fan, showing fan, driving motor, and magnetic coupling

Fig. 7. New boiler No. 19 from operating floor, showing traveling grate stoker, chutes, feedwater regulator



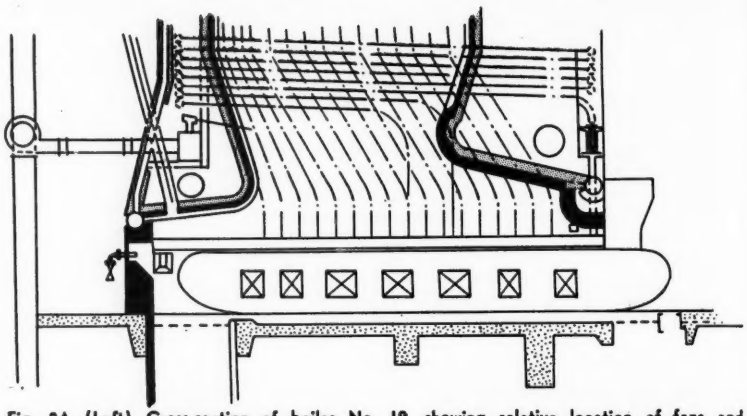


Fig. 8A (Left) Cross-section of boiler No. 19, showing relative location of fans and economizer. Fig. 8B (Above) Details of arch construction, overfire air provisions, furnace construction. Capacity 125,000 lb steam per hr, 400 psi, 700 F steam temperature

plant. These boilers range in size from small 550-hp, 185-psi header pressure, stoker-fired units to 125,000-lb-per-hr units operating at 400 psi and generating 700-F. steam. The older boilers, which on a 185-psi steam header system, will be replaced, under the long-range phase of the program, by boilers with higher pressure and greater steam capacity. The way in which the various boilers are connected to the different pressure systems is shown in Fig. 2. The new boiler is No. 19.

The furnace of the new boiler is designed for burning high-volatile Central Illinois 1¼ in. screenings. As shown in Fig. 8, and induced-draft fans and an economizer for reducing outgoing gas temperature to about 410 F. Because of the high sulphur content of the coal, heat exchanger equipment has been provided so that boiler feed water enters the economizer at a temperature of about 260 F. to prevent any chance of sulphur condensation. Completely water cooled, the furnace has a heat release of 23,000 Btu per cu. ft. per hr. under maximum operating conditions.

A major change under the program, is the conversion of electrical equipment from the type normally installed in industrial plants to the heavy-duty equipment generally used in public utility plants.

Although new power plant equipment has been added periodically since the present power house was completed in 1928, to provide power for new installations such as the soybean oil processing plant, completed in 1944, this is the first major alteration required on electric power bus and switchgear system due to the original long-range planning.

Existing 440-v switchgear is being replaced by heavy-duty equipment. New 13,800-v, safety-type switchgear and tie transformers are being installed in the power house, which will permit direct distribution of power at 13,800 v through underground power feeders, now being installed, to the eastern section of the plant area. Figure 3 shows diagrammatically the ultimate electrical system of the plant.

On one of four turbine generating units operated in the Staley power plant, a 2500-kw unit, a 400-psi steam turbine, Fig. 10, has been installed to increase efficiency. In spite of the power increase planned, the firm will continue to purchase a part of its power supply from the local power company.

R. E. Greenfield is general superintendent of the Staley plant and John W. Winings is power engineer.

Planning for the modernization and expansion of the power facilities was begun two years ago. Burns & McDonnell are the consulting engineers and H. K. Ferguson Co. is doing the construction work.

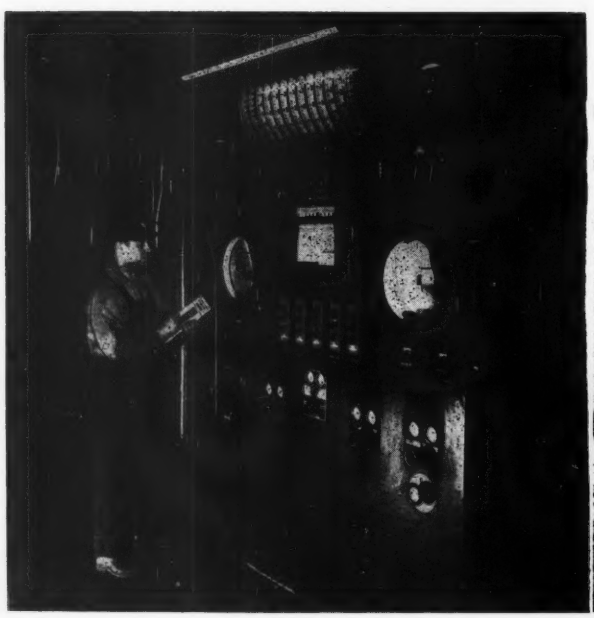
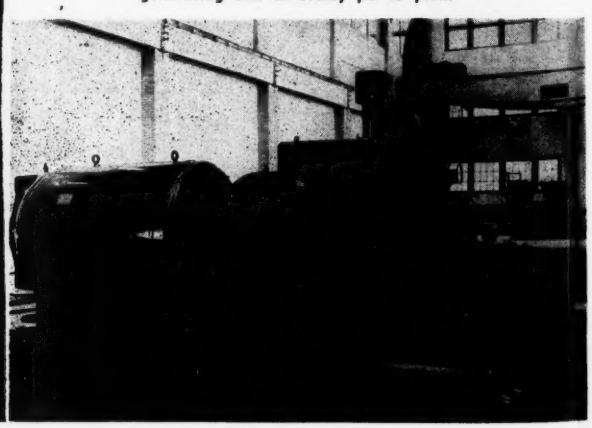


Fig. 9. View of operator checking meter readings on control panel of new Boiler No. 19

Fig. 10. New steam turbine installed to drive old 2500-kw 440-v generating unit in Staley power plant



Coal Freezeproofing and Corrosion

We Need More Data

THE ARTICLE entitled More on Handling Frozen Coal published in the September, 1948 issue, also Question No. 433, Do Coal-Freezing Preventives Corrode Coal-Handling and Burning Equipment? December, 1948 issue, stimulated great interest among readers.

Nobody debates the effectiveness of chemical treatment in freezeproofing coal. But, in recent years, this very effectiveness has created the possibility that chemicals used in the process may pass along with the coal into the plant and cause corrosion of coal-handling equipment.

How much corrosion and where? Will you get corrosion anyway from moist coal, without the chemicals? How much faster, if any, will it proceed with the chemical solutions present? Does elimination of labor in handling frozen coal counterbalance any equipment damage from corrosion by the chemicals?

One engineer here sums up the available information; shows that there is much evidence on both sides of the question; holds that we need much more careful and authoritative studies by qualified technical committees—such as those of ASME or EEI. Another engineer relates a case study of corrosion in a particular plant.

What has been YOUR experience? What conclusions have YOU drawn?

Better think about it this summer—next winter might be another severe one.

Use of Chloride Salts for Freezeproofing of Coal for Utility Boilers

By **FRED M. REITER**
Material Research Engineer, The Dayton Power and Light Co.

USE OF chloride salts, calcium and sodium, for freezeproofing coal has been discussed for many years. Tests have been run by a number of agencies, acting independently, from time to time, resulting in contradictory reports both in favor of and against the use of these salts in minimizing the problem of unloading coal frozen in transit from mine to ultimate point of consumption.

Difficulties of unloading cars of frozen coal are manifold. They include delays and increased labor requirements, demurrage and other costs, and a nuisance that irritates consumer, supplier and transportation facility. Acuteness of the problem has led to the adoption of varied practices. Use of torches, thawing fires,* hammering with crane buckets and air hammers is damaging to equipment. Safety rules become relaxed in abnormal coal handling practices. The use of noisy shakeouts and vibrating equipment is not conducive to good public relations.

Hence the use of anti-freeze became accepted as the least of all evils. Quantities of chloride salts required for prevention of freezing have been worked out for various moisture contents of the coal for different temperatures, as in Table I.

During the past few years beneficiation of coal by washing has been greatly extended. Mechanization of coal mining has accelerated the practice of washing coals with water to appreciate heat values, reduce ash content, increase boiler capacities, and improve certain operating conditions. Moisture content of many washed coals has approached and even exceeded 10 per cent, aggravating the freezing problem. In these cases, use of anti-freeze chemicals has practically become a requirement in zero weather periods. The quantity of chemical additions required to prevent freezing has correspondingly risen to about double previous needs.

The fly in the ointment is the corrosion that can result from the use of chloride salts. Here the problem is stymied by the lack of definite information. Opinion is about equally divided for and against their use. Available data are generally based upon work done by universities on domestic stoker equipment or by research institutions on projects initiated and supported by the manufacturers of chloride salts or the coal producers.

Modern steam generators used in the utility industry today are so gigantic, complicated, and costly that reliance on laboratory experiments

* Editor's Note:—There seems to be increased interest in the use of thawing pits, of the type described in Radiant Heat Thaws Frozen Coal Cars, *Power Plant Engineering*, March, 1946.

[1] *Information Bulletin No. 7*, December, 1945, Bituminous Coal Research, Inc., by John F. Foster and Ralph A. Sherman.

Table I. Suggested weights of Rock Salt or Calcium Chloride for freezeproofing coal shipments. Weights in pounds of rock salt or flake calcium chloride per ton of coal [1]

	SURFACE MOISTURE, Per Cent		
Temperature F.	3	6	9
20	3.4	6.8	10.2
10	5.0	10.0	15.0
0	6.6	13.2	19.8
—10*	8.2	16.4	24.6
—20*	9.2	18.4	27.6

* Calcium chloride must be used for temperatures below -6 F.

Table II. Data from small test boiler reported in U. S. Bureau of Mines Bulletin No. 404. Pittsburgh coal, 2% moisture, ¾ in. by 1 in. 322 cu ft air per sq ft per hr.

	Without Chemicals	With 2% Sodium Chloride	With 2% Calcium Chloride
Rate of combustion, lb coal per sq ft per hr	28.3	24.0	23.0
Per cent tar and soot in gases	0 013	0.026	0.044
Per cent combustible in residue	2.5	0.9	1.3
Fusion temperatures, F.			
Initial deformation	2050	1920	1975
Softening point	2180	2025	2075
Fusion point	2500	2395	2465
Per cent of sodium and calcium in the ash, as oxides	—	16	15
Per cent of sodium and calcium retained in the fuzed slag as oxides	—	26	39

or on tests on domestic stokers is certainly not justified. Serious damage may not show up in several years. Premature failure of large bunkers, pulverizers, heat exchangers, or other major portions of the equipment presents a sizable risk in the use of corrosive salts. Corrosion of the steel under-structures of automotive vehicles due to the use of chloride salts for ice prevention on public streets and highways has resulted in a general adoption of rust-preventive impregnation of these portions of new vehicles. *The problem is not fancied, but real.*

The author initially canvassed a number of authorities in search of definite evidence of the corrosive effects of chloride salt additions to coal. These sources included engineers and research organizations directly interested in this problem; power and corrosion publications and pertinent literature. The information accumulated was not conclusive. In brief, some of the data obtained indicated:

1. Doubt that significant corrosion above the acidity of normal coal products would occur, or that the corrosion of metals and refractories at high temperatures would be significantly affected by the amount of calcium chloride likely to be found on treated coal. A number of utilities have used coal treated with calcium chloride or salt for freeze-proofing for some years, without report of difficulties from corrosion of metal or refractories.[2]

2. The Dow Chemical Co. has burned approximately 2,000,000 tons of coal treated with calcium chloride year around. Their fuel engineers report no noticeable deterioration. Less slagging occurs on the boiler tubes and their power plant is cleaner in addition to the advantage of having easily unloaded coal for winter use.[3]

3. On underfeed stoker screws, the addition of 10 lb of calcium chloride per ton of neutral coals containing up to 5 per cent moisture has shown little increase in corrosion weight loss; but with acid coals, 6 per cent to 14 per cent moisture content, corrosion weight loss was increased approximately one third.[4]

4. Eight-day immersion tests of steel plates in beakers containing Elkhorn coal treated with 3 gals of tap water; and solutions of 2.2 lb per gal and of 3.0 lb per gal of calcium chloride, showed losses, in milligrams per square inch of surface per day, of 0.04, 0.32, and 0.32 respectively. Immersion and spray tests in these solutions without the presence of coal indicated generally greater losses in tap water than in the calcium chloride solutions.[5]

[2] Data from Battelle Memorial Institute, letter dated Sept. 17, 1948.
[3] Basic information by Wm. A. Staab, Calcium Chloride Association, Sept. 4, 1948.
[4] *Technical Report No. IX*, Bituminous Coal Research, Inc.
[5] Battelle Memorial Institute, *Progress Report*, March 24, 1943.

Table III. Losses in weight of domestic stoker screw; treated and untreated Sewickley coal, 1¼ in. by ⅜ in., 7-month heating season

		Untreated Coal	Treated with Calcium Chloride	Treated with Calcium Chloride plus Inhibitors[6]
Loss with stoker operated cold for 22 weeks without fire,	lb	0.22	0.87	0.87
Loss, screw packed with coal but not operated (stagnant), held for 60 days,	lb	0.03	0.03	0.03
Loss in normal operation, first burning test for 6 months,	lb	0.10	0.16	0.30
Loss in normal operation, second burning test for 6 months,	lb	0.23	0.30	0.35
Original weight of stoker screws	lb	26.75	27.25	25.63

[6] Inhibitors were sodium dichromate and sodium hydroxide.

This question of corrosion of boiler equipment due to chloride additions was placed before the readers of POWER GENERATION by the author (December 1948 issue) in order to obtain direct field experiences. These comments were returned:

1. From an engineer with wide experience in treating coal at the mine and handling it during transit and into the plant: "I personally know of no serious corrosive effect of a practical nature resulting from the proper use of calcium chloride in cases where the producer of the coal has either thermally or mechanically dewatered the coal before loading. Where washed coal has not been adequately dried before loading, corrosion trouble would quite likely result. In all cases I would avoid the use of rock salt."

2. Conclusions from a member of a large coal company, based upon *Information Bulletin No. 5* of the Bituminous Coal Research, Inc.: "There is no acid reaction from cal-

(Continued on page 88)

This Plant Traces Corrosion to Coal Freezeproofing Chemicals

By WILLIAM C. JUSTICE

IN THE September, 1948 issue of POWER GENERATION, an article entitled More on Handling Frozen Coal presented a concise description of the methods used to ease the burdent of unloading frozen coal. The principal methods are to use (1) oil sprayed over the coal and (2) a salt, such as calcium chloride, sprinkled over the coal in the car.

There is no question concerning the benefits of freeze-proofing coal. Cost of labor for unloading and demurrage on cars should be substantially reduced, so that the customer is the chief beneficiary.

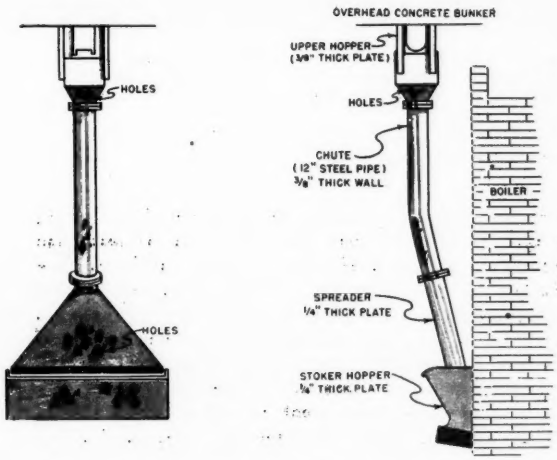
However, the use of calcium chloride sprinkled over the coal is not an unmixed blessing, even though all the literature on the subject to date seems to extol the advantages, and to say nothing of the disadvantages.

After the calcium chloride is sprinkled over the coal, water is often picked up in transit in the form of rain or snow during the average week's trip of the coal car from mine to customer. This water dissolves the calcium chloride to form a weak salt solution that is somewhat corrosive.

It sounds inoffensive enough to say that only 2 or 3 lb of calcium chloride are added to freeze-proof each ton of coal during the milder winter months, with 5 lb of calcium chloride added per ton of coal during the severely cold months. But, assuming an average of 3 lb of calcium chloride per ton of coal, it is evident that every 55-ton coal car is going to have 3 × 55 or 165 lb of calcium chloride sprinkled over the coal. Multiply this 165 lb per car by the number of cars unloaded during the winter months, and the result will be a staggering figure, considering the corrosiveness of calcium chloride. This salt, which in total will probably be reckoned in tons, will have opportunity to wreak its slow destruction on all the coal-handling and using equipment in the plant, from unloading hopper to stoker hopper or pulverizer.

A plant with which I have had experience unloads approximately 30,000 tons of coal during the months of December, January, February, and March, inclusive. This represents roughly 550 cars of 55 ton capacity each. Based on an average of 3 lb of calcium chloride per ton it is apparent that 3 × 30,000 or 90,000 lb of salt were sprinkled over the coal unloaded during these 4 months. This 90,000 lb of calcium chloride, or 45 tons, is enough to nearly fill a coal car, and it must be assumed that a major portion of this carload of salt entered the plant.

In this plant, steel chutes and spreaders carry the coal from overhead bunkers to the steel hoppers of 16 multiple-retort underfeed stokers. The original chutes and spreaders of these stokers had been



Coal chutes in plant referred to by William C. Justice, showing location of corrosion after 3 or 4 years service

in service for more than 30 years and the stoker hoppers for more than 20 years, before they were replaced about 3 or 4 years ago. No holes or badly pitted spots were noted in the old chutes, spreaders, and hoppers, although they had thinned evenly. No calcium chloride freezeproofed coal had been unloaded during any of these preceding 30 years.

During the past two winters, calcium chloride freezeproofed coal was unloaded at this plant. Coal has been received from the same two mines since 1939, so that the characteristics of the coal have not changed.

In the summer of 1948, a number of chutes, spreaders, and stoker hoppers have broken out with sizable holes as shown in the illustration. The holes generally appeared on the under sides of the chutes, spreaders, and hoppers along the path that water in the coal would be expected to follow. These pitted spots were also at the sections of greatest abrasion, where the rust products would be swept away by the flow of coal to continually expose fresh steel areas to corrosive attack.

It has been necessary so far to replace nearly half of the coal chutes and to weld steel patch plates over the flat sections of the spreaders and hoppers of a majority of the stokers. A steel coal-unloading hopper under the railroad track was also rusted through, and replaced last summer. This unloading hopper had been in service since 1936; and, being outdoors, would naturally not be expected to last as long as equipment installed indoors. However, it is believed that its life was materially shortened by the calcium chloride unloaded into it with the coal during the past two winters.

It is known that damp coal alone is generally corrosive. Yet the fact remains that the old chutes, spreaders, and hoppers had handled damp coal with all its natural corrosiveness for more than 20 years before replacement was necessary. When new chutes, spreaders, and stoker hoppers start to become full of holes in less than 4 years, it is apparent that something more than the coal's natural corrosiveness must be acting on the steel.

The danger in calcium chloride entering a steam plant by way of the coal lies in the slow-working action of the salt. The insidious corrosion of unloading hoppers, chutes, stoker hoppers, and other coal handling equipment may go on for two or three years before its effect may be detected. It may possibly cause a plant shut-down to permit replacement of corroded equipment.

One trend in reducing corrosion in coal handling equipment in power plants is reported to be the use of glass or enamel lining in coal chutes, but there is very little information about it.*

Use of calcium chloride has been accompanied by little fanfare, and its corrosiveness seldom discussed. In the city of Washington, D. C., the Highways Department started using calcium chloride to help melt ice on the city streets. An editorial in the local newspaper from an anxious motorist asked about the possible corrosion to the undersides of automobiles. Some Highway Department experts issued a statement that there was no danger whatsoever. In spite of this assurance, a great number of cars had spots rusted through their fenders, and now the car manufacturers are painting the undersides of fenders and chassis of cars with a protective mastic paint for about $55 additional.

Until steel can be protected adequately and indefinitely against corrosion, use of calcium chloride freezeproofed coal will in all probability result in accelerated replacement of equipment exposed to the salt.

* Editor's Note: Such use of glass-lined chutes has been reported to us but in one particular case investigated we found the report incorrect. Glass lined chutes were used in this case primarily to eliminate sticking of coal, especially wet coal. But the anti-corrosion property of the glass was not a factor in its selection.

In this particular station, a discharge spout from an apron feeder to a belt conveyor is lined with 1-in. thick glass, set with a thick mastic in an extra rigid steel supporting frame. After approximately two years service this lining was cracked by large frozen lumps of coal falling on it, and this hazard was then eliminated by placing a grill over the receiving hopper above the apron conveyor. The lining, though cracked, remained in service for an additional four years but is now being replaced.

Large transverse "crickets" form the individual groups of hoppers in the newer bunkers, and these will be glass lined to a point approximately 6 ft from the hopper outlets. The purpose of this again is to prevent "rat-holing" in the coal, caused by sticking. The remaining surfaces of the bunkers and hoppers will be lined with 2½ in. of gunite as a corrosion preventative.

Dow Chemical Takes Own Medicine—No Corrosion

In answer to our request for comments on Question No. 433, we received the following from The Dowflake Technical Service at Midland, Mich.

WE HAVE been using mostly ½ in. to 0 coal treated with 32 per cent calcium chloride solution at the rate of 2 gal per ton for the past 5 years. This amounts to approximately 500,000 tons treated coal annually.

Very recently a complete inspection has been made of our burning equipment with the following conclusions, which are in line with your question:

1. There is no more corrosion with $CaCl_2$ treated coal in all of our handling systems than we had years ago. We have always had some corrosion probably due to water, sulfur, and the like, and we have no evidence that the presence of $CaCl_2$ has either retarded or accelerated the normal corrosion.

2. Calcium chloride treated coal has been used for five years in our 1250 psi boiers and, with close observation, no apparent damage or corrosion has been noted, either in the generating section nor in the air-heated sections of the steam generators.

3. Excessive corrosion was detected on the water walls sometime ago. This condition was traced to sulfur trioxide and corrected by the introduction of excess air along the walls.

4. No noticeable corrosion is in evidence on the conveyors, transfer pipes, feeders, bunkers, hoppers, grinders, where the coal is under constant movement.

We have had no experience with sodium chloride (salt) in treating coal.

Oil Systems for Industrial Steam Turbines

By **FRANK C. LINN** General Electric Co.

Part II:—How to obtain best operating performance of lubricating and governor systems on industrial steam turbines of less than 10,000 kw capacities . . . Effects of dirt . . . How rust forms; how rust-inhibited turbine oil prevents it . . . Water worst offender in turbine lubricating systems . . . How to keep it out . . . Emulsions . . . How sludge forms . . . Air and foam . . . Temperature of lubricant . . . How acid number measures oxidation . . . Part I, April issue, detailed equipment used in turbine oil systems, told how to put it into service . . . Subsequent articles will show how to get the right oil, keep it right and get best results from it

FOLLOWING PROBLEMS in turbine lubricating systems should be considered by turbine manufacturers, oil suppliers, and the operators in order to obtain best operating performance.

Dirt is usually composed of core sand, metallic chips, mill scale, gasket material, paint flakes, cinders, fly ash, and dust.

The core sand comes from the surface of rough castings, such as pump housings, bearing brackets, and lining casings. Chips come from machining and usually collect in the cored and drilled passages. Mill scale is on the inside of the piping and sheet metal tanks. Cinders, fly ash, and dust found in the lubricating system come from the atmosphere.

Core sand, cinders, and metallic chips, if circulated in the lubricating system, will collect in small passages and may cause considerable damage. The journals and bearings may become scored, the orifices in the oiling system may plug, the pilot valves and operating pistons in the governing mechanism may score and bind.

Some of the foreign materials, such as metallic chips, scale, and the like, may increase the rate of oil oxidation; this results in sludge formation.

The operator should make every effort to be sure that his system is clean when the unit is originally installed, and to take every precaution to see that foreign matter is kept out of the oiling system after installation.

Rust and How to Prevent It

Rust takes place on the ferrous metal parts of the lubricating system. It takes place only in the presence of water or water vapor. Below the oil surfaces, black iron oxide is formed; and above the oil surfaces, red iron oxide is formed. The black rust is magnetic oxide and has frequently been assumed to be carbonized oil. Chemical analysis of the black material, however, indicates that it is iron oxide and not a carbon product. Black rust is formed where the amount of oxygen present is limited.

It cannot be assumed that, because water does not accumulate in the bottom of the oil tank, rusting cannot take place. Many installations have had faulty governor operation due to formation of black oxide at positions of close clearances in the governing system, when water was not being extracted by the oil conditioning equipment. Inspection of the oil would show a haze, which indicated that water was being held in suspension in extremely small quantity. This water was carried by the oil to the bright ferrous parts and black rust resulted. The use of rust-inhibited oils has eliminated this difficulty.

Rust in the lubricating system is one of the worst offenders in the operation of a turbine. It accumulates very gradually and builds up with time. If it comes loose, it may plug orifices and may result in burned-out bearings and a damaged rotor. That which accumulates in pilot valves and operating cylinders of the governing mechanism produces sticking and erratic governor operation.

Recently an industrial turbine was shut down because of excessive vibration. Upon inspection, the high-pressure bearing was found to have burned out. Further inspection revealed an accumulation of black rust in the orifice to the bearing. The pedestals, oil tank, and parts usually inspected showed no signs of rust. However, the return oil lines from the generator pedestal had an accumulation of considerable black rust.

This experience convinced the operators of the advisability of changing to a rust-inhibited turbine oil.

Rust can be eliminated above the oil level by painting the surfaces with an oil and water resistant paint.

The operator can have a non-rusted lubricating system by eliminating rust that exists in the lubricating system during installation, by using rust-inhibited oils, and by maintaining the turbine so as to keep water out of the lubricating system.

Water Is Worst Offender

Water is the worst offender in causing lubricating systems to deteriorate. It is the main cause for rusting; it produces emulsions with the oil; it removes water soluble acid from the oil that may attack the metal parts; and it tends to wash the rust inhibitor and some oxidation inhibitors out of the inhibited oils.

It comes into the lubricating system from the sealing steam glands, leaks in the oil coolers, and condensation from the atmosphere.

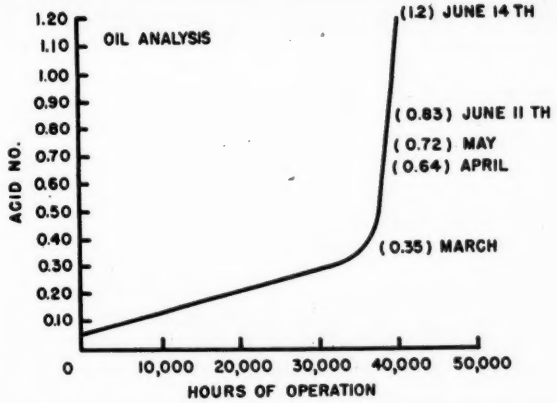
Most of the water that gets into the lubricating system is from the shaft seals. Quite frequently this takes place during the starting cycle if improper regulation of the steam or water seal valves occurs. In other instances, improper operation or maintenance of the shaft seal equipment may allow steam or water to leak out of the seal and be drawn into the bearing housing.

Cooling Water

The pressure of the cooling water in the oil coolers should be slightly lower than the oil pressure so that, in case of a leaky cooler tube, there will be a flow of oil into the water side of the cooler instead of water into the oil. In some instances, where the water pressure is higher than the oil pressure, leakage of water into the oiling system does occur.

Condensation Effects

If parts of the oiling system, such as the tank, bearing housings, pump casing, and the like, are kept at a temperature somewhat below the temperature of the internal atmosphere, condensation on the metallic parts will take place and this supplies a certain amount of water to the system. During operation, air circulation against the bearing housings should be kept to a minimum in order to allow the metallic parts to more nearly coincide with the temperature of the internal atmosphere. During the shutting-down cycle, the pedestal should be allowed to cool gradually in order to reduce condensation.



Plot of acid number of a turbine oil, over a number of years, in a plant of Eastman Kodak Co.

If water is getting into the lubricating system from any source, it should be removed immediately by the judicious use of the oil conditioning equipment.

The fact that, at some time or other, water may enter the lubricating system makes it advisable for the operator to have an oil conditioning equipment in operation and to use an oil that will separate readily from water, will not emulsify, and will protect ferrous metals against rust in the presence of moisture.

Emulsions and What They Do

For practical purposes, turbine oil emulsions may be considered as a mixture of oil, water, solids, and air. These substances, although they generally do not mix with one another to form a solution, can be combined mechanically in such a manner that they are held in suspension. The resultant types of emulsions range from milk-like mixtures to a tough liver-like material that may deposit on bearing areas, oil reservoirs, cooler tubes, and so on. These latter formations are often totally insoluble in petroleum products and, although usually considered as emulsions, are really deposits of petroleum decomposition products.

Emulsions in themselves may not always be harmful. However, they do not make good turbine lubricants and, when pumped through the lubricating system, may do harm. The solids present may deposit on the bearing surfaces and in the close clearance areas of the pilot valve and governing mechanism. The solid deposits may be in such a form in the oiling system as to eventually disrupt fluid film lubrication and thus cause bearing failure; and to produce stickiness in the governing system, and thus cause erratic governing. The oil companies are familiar with this problem and are producing turbine oils that separate readily from water and do not form emulsions in the lubricating system.

Laboratory tests are run on new oils to show whether the oil separates quickly from mixtures formed with steam or water fed into the oil. This initial ability to separate from water, once the oil has been placed in service, may be rapidly reduced because of contamination with dirt, acid materials, or oxidation products of old oil, which may have been left in the system.

The operator can keep his lubricating system free from emulsions by keeping water, dirt, and products of oil oxidation out of the lubricating system.

Sludge

Sludge formation is the result of oil oxidation; however, it is generally considered by the operator as the accumulation of dirt, emulsions, and solid matter which accumulates in various parts of the lubricating system. Sludge is detrimental primarily because it deposits upon surfaces with which it comes in contact and causes a general clogging of the lubricating system.

The operator can do a great deal for the prevention of sludge; first, by the use of oxidation inhibited oils; and, second, by keeping water and dirt out of lubricating system and by the judicious use of the oil conditioning equipment.

Air and Foam

Oil retains air in solution at all times. Turbine oil at atmospheric conditions will have approximately 15 per cent by volume of air in solution. During operation, air is mixed with the oil in various ways. A vacuum exists in a portion of the periphery of most bearings. Thus, air is drawn into the bearing and mixed with the oil to over-saturation at atmospheric conditions. Turbulent flow of oil in the return lines accumulates a certain amount of air. Oil discharged into a tank above the oil level entrains air.

The accumulation of excess air in the oil produces foam, which may build up in the pedestals and return oil piping to cause leakage.

Foaming Prevention

Modern turbine oils either have, or can have added to them, an inhibitor to reduce their foaming.

Some slushing compounds and pipe joint compounds may, if mixed with the oil, cause foaming. It is therefore essential that new systems be properly flushed in order to eliminate all such materials.

If objectionable foam is present, the operator should check the return oil pipe to see if it is sloping sufficiently to allow the foam to be carried away from the pedestals; or he should work with the oil supplier to obtain an oil which has low foaming characteristics.

The return oil piping should be constructed with a minimum number of bends and, where they exist, they should have as large a radius as possible in order to eliminate eddying and resultant generation of foam.

Care should be taken to see that the return of the discharge from the bearings to the oil tank is near the top of the oil level, in order to keep the entrainment of air to a minimum. The discharge of the relief valve should be below the oil level.

Temperature of the Lubricant

The temperature at which the lubricant operates affects a number of factors pertaining to its performance. These are as follows:

1. Foaming:—The quantity of air that will be retained in an oil depends upon the temperature. By raising the temperature, it is possible to expel a greater amount of air and thus reduce foaming.

2. Oxidation:—The rate of oxidation of oil obeys the same law as do all organic materials; namely, that for each 10 C increase in temperature, the life of the product is reduced one-half. Some people have recommended that the oil be operated under relatively cold conditions in order to maintain a low rate of oxidation and thus a longer life of the oil. This, however, results in increased friction loss in the bearing due to shearing the oil at higher viscosities. Oils at the lower temperatures also carry a greater amount of air in solution and water in suspension than at higher temperatures.

In order to maintain the lower temperature, it is essential to use excess cooling water flow. A number of oxidized products that are soluble in oil at higher temperatures deposit at the lower temperatures; and this is one of the reasons why oil coolers plug earlier than other portions of the system. The lower the temperature of the cooler tubes, the worse this condition.

Experience indicates that, with temperatures of approximately 120 F of oil to the bearings, of 130 F minimum tank temperature and of 140 to 160 F bearing outlet temperature, a balance exists to give best service performance. With the inhibited oils, some people are recommending even higher operating temperatures.

Fire Hazard

The flash point of turbine oils is between 330 and 400 F and the fire point is approximately 40 F higher.

(Continued on page 94)

Waterside Completes Its Topping Program

Waterside No. 1 and Waterside No. 2, Siamese twins of the Consolidated Edison Co. of New York have been familiar landmarks of midtown Manhattan for many years—they are among the oldest of the New York Stations. Their long rows of water tube boilers arranged in two stories at one time were considered the last word in power plant practice. Through the years these stations have gradually been modernized. In 1942, the 92 boilers in Waterside No. 2 were removed and topping units installed. In 1945 the topping program at Waterside No. 2 was started. As described by Mr. Roberts this topping program is now completed

By R. T. ROBERTS Division Engineer, Mechanical Engineering Department, Consolidated Edison Company of New York, Inc.

WATERSIDE STATION of the Consolidated Edison Co. of New York Inc. actually consists of two stations; Waterside No. 1 occupying the block from East 38th to East 39th St., and Waterside No. 2 the block from East 39th St. to East 40th St. The stations face 1st Ave on the west and the East River Drive on the east, with overhead bridges to the coal and ash handling facilities on the water front and tunnels under the Drive for water. Waterside No. 1, to the south, is the older of the two stations.

Some years ago, the steam mains of the two stations, then both operating at 200 psig, were connected by overhead lines across East 39th St and piping for the return of condensate was installed in a tunnel under the street. Bridges for physical passage and for coal conveyors completed the unification, so that the two were operated as substantially a single station.

Later, the 92 boilers in Waterside No. 2 were removed and 8 topping boilers, supplying steam to 4 topping turbines were installed. Low pressure steam exhausted from the topping turbines was used to supplement that generated by the low pressure boilers in Waterside No. 1. The two steps in the Waterside No. 2 topping program were described in several publications at that time, among them POWER PLANT ENGINEERING, Sept. 1937 and *Combustion* of September 1937 and March 1942.

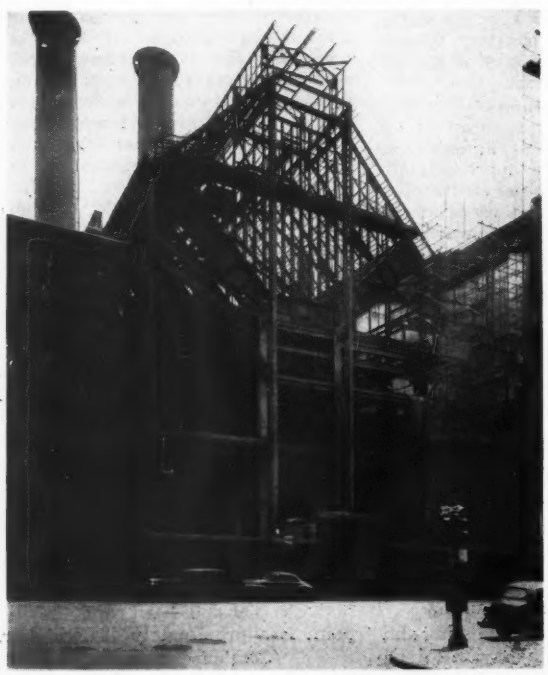


Fig. 1 Demolition Progress on West wall of Waterside No. 1 boiler house

In 1945 the topping program at Waterside No. 1 was started. This renovation was somewhat more extensive than required by Waterside No. 2, as it practically required unroofing the entire boiler room as well as completely rebuilding the west end, while at Waterside No. 2, some of the overhead bunkers and the roof, with the exception of the stacks were not substantially changed. Figs. 1, 2 and 3.

In the turbine room, however, the topping program was preceded by the installation of two new 60,000 kw low pressure turbines, requiring the removal of three 20,000 kw existing vertical generators. These new machines are fed from the low pressure system, which receives its steam from the topping boilers in Waterside No. 2. The two new 50,000 kw topping turbines in Waterside No. 1 are located in the boiler room; No. 8 unit to the west of Boiler No. 80 and No. 9 unit to the east of Boiler No. 90, in order to reduce the overall length of the high pressure steam leads.

The program was authorized as two projects. The first topping boiler was purchased and work started. This contemplated the removal of 37 old boilers and their auxiliary equipment, together with the relocation of other auxiliaries to the eastern area of the boiler house, to serve the remaining boilers.

Growing demand for more capacity however required the purchase of the second boiler and turbine, and the dismantling of the remaining 16 low pressure boilers and their auxiliary equipment. The two projects were then combined and proceeded as one installation.

In choosing the initial steam con-

ditions and cycles for study, a number of inter-related factors were considered. The higher the initial pressure and temperature, the greater the capacity in the topping unit for a given exhaust pressure. The pressure should be made as high as consistent with adequate steam temperature for the low pressure turbines, with due consideration given to cost of boiler and other pressure parts.

With a fixed initial temperature to the topping unit, increasing initial pressure reduces the temperature in the exhaust, which was limited by the low pressure turbines at about 200 lb and 500 F. Conversely reducing the pressure raises the exhaust temperature. It was desired to maintain about 100 deg of superheat or above in the steam to the low pressure turbines since maintenance becomes excessive due to water erosion in the lower stages when sufficient superheat is not maintained.

H-P Reheat considered but proved unattractive

High pressure with reheat was considered but proved unattractive. One typical case of a reheat cycle is shown in Scheme F_2. Since the steam temperature to the low pressure turbines was limited to about 500F, the economy of reheat was limited, while the major portion of the reheat investment would be required.

At the time of making this study the Company, as well as others, had operating experience with 950 F steam. There was, however, no experience in operating at 1000 F. While Scheme D_1 shows an improvement over Scheme C_1, practical considerations favored Scheme C_1, which established the pressure at 1600 psig and temperature at 950 F.

The steam generating units selected are of the three drum bent-tube type and were designed and furnished by Combustion Engineering Co. They are rated to deliver continuously 1,000,000 lb of steam an hr for 24 hr, at 1600 psig and 950 F at the turbine throttle valve when fed with water at 437 F. Design pressure is 1800 psig. Fig. 4.

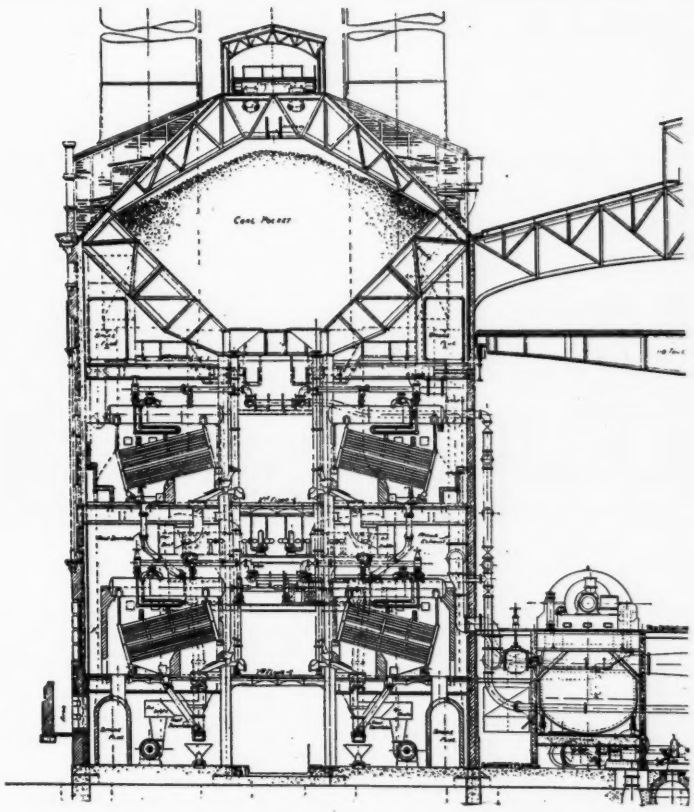


Fig. 2 This is a cross section of Waterside No. 1 before modernization. Note the two boiler floors.

The boilers are arranged opposite hand to each other so that the superheater outlet of the boiler is nearest its turbine. Following past practice, a single boiler serves a single turbine, so that a non-return valve is not required between the boiler and the turbine, and the Boiler Code covers the main steam piping to the turbine throttle. Topping turbines exhaust to the station 200 psig steam mains. Fig. 5.

Each unit comprises a completely water cooled, continuously slagging bottom furnace, Elesco superheater, Elesco economizer and two Ljungstrom air preheaters.

The furnace volume is 68,500 cu. ft., with heat release of 15,700 Btu at 925,000 lb evaporation. The furnace is completely water cooled, with the lower 20 feet of the wall tubes alumnized to prevent sulphide attack, Fig. 7. All tubes are 3 in. diameter, with front and rear walls composed of bifurcated tubes on 3⅛ in. centres. Side wall tubes are on 3⅛ in. centres but not bifurcated. At the superheater screen the rear wall tubes are spread four rows deep in the direction of gas travel on 12½ in. centres.

To supply water to the furnace wall tubes, seven 10 in. OD downcomers lead from the 36 in. water drum to an inlet header located below the furnace floor. Supply tubes connect the inlet header and the individual headers. The upper water drum is 60 in. I.D., 3-29/32 in. thick and 44 ft 8 in. straight length. It is equipped with a bubble type steam washer.

The Elesco superheater is of the vertically pendant type having 29,720 sq. ft of surface disposed in a primary (Low Temperature) section of 24,425 sq ft and a secondary (High Temperature) section of 5,295 sq ft. It is located between the screen formed by the rear wall tubes and the downcomer bank and consists of 2⅛ in. OD tubes.

Tubing in the superheater elements nearest the furnace is chrome-molybdenum alloy, seamless low-carbon, hot-finished steel. In the

Table showing comparison of various steam conditions

Scheme	B_1	C_1	D_1	F_2
Steam at HP Turbine Throttle	—	—	—	—
Pressure Psig	1,250	1,600	1,600	2,400
Temperature F	925	950	1,000	950
HP Flow Lb per hr	950 000	947,000	920,000	960,000
LP Flow Lb per hr	810,000	806,000	785,000	766,000
LP Temperature F	527	494	523	500
Feedwater Temperature F	441	441	441	489
Reheat pressure psig	—	—	—	1,535
Reheat Temperature F	—	—	—	950
HP Generation MW	45.4	51.2	52.1	60.1
LP Generation MW	69.1	66.8	67.3	63.9
Net HP & LP Generation MW	103.3	106.3	107.9	111.0
Heat Rate for HP and LP BTU per Kwhr	10,850	10,530	10,375	10,085

All studies made with a constant heat input of 11,200 x 10^6 Btu and 87½% boiler efficiency

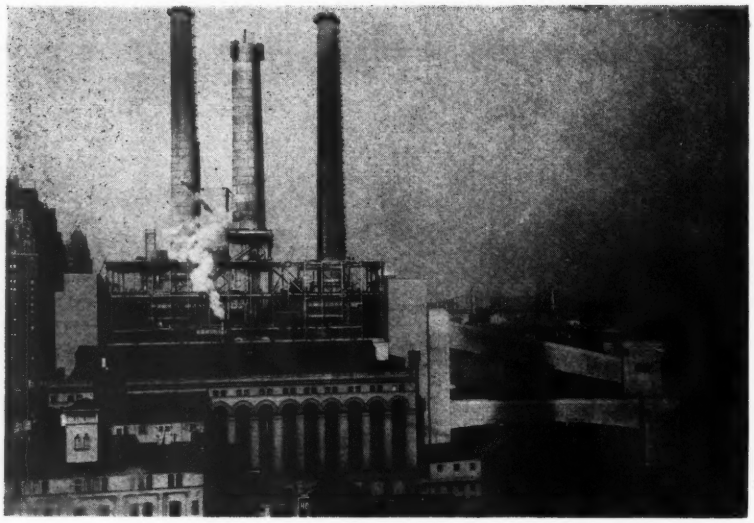


Fig. 3 General view of boiler house and stack erection

primary superheater nearest the furnace, tubing is carbon-molybdenum, seamless, low-carbon, hot-finished steel and in that part farthest from the furnace low-carbon, hot-finished steel.

The superheater is designed to raise the temperature of the steam to 950 F plus or minus 10 degrees when delivering steam of 1600 psig to the turbine throttle. Steam temperature control at full load temperature is operative above 750,000 lb per hr.

A horizontal tube, split type Elesco economizer is provided, having 2 in. O.D. finned tubes 46 wide and 16 high for each half, on 5 in. vertical and 3 in. horizontal spacing. Tubes are hot-finished, low-carbon, seamless steel, with total heating surface of 32,750 sq ft. Gas flow is vertically up with parallel water flow. The entire economizer is hung on the vertical water downcomer tubes, eliminating all hanger rods exposed to the heat of the flue gas.

Each boiler has two Ljungstrom air preheaters, each having 130,000 sq ft of surface. The elements are 72 in. deep, disposed in layers of 32 in., 30 in. and 10 in. The upper 10 in. is in basketed sections, with a spare set of basketed elements.

When this surface is fouled, it is replaced by the spare baskets, in order to reduce outage. Spare baskets are washed and stored. A single nozzle reciprocating soot blower is located above each air heater on the air side to maintain cleanliness. A damper controlled by-pass is provided around the heaters to aid in maintaining higher plate temperatures at low load in order to diminish fouling and corrosion.

Soot Blowing

Each boiler is equipped with its own separate soot blower system, independent of that on the other boiler except for common cooling water pumps for telescopic soot blowers. Two pumps, one a spare, are provided, each capable of supplying the demands of both boilers. They are automatically controlled to start and stop as required to supply water when the water cooled telesecopics are operating.

The system for each boiler consists of a control panel providing for automatic sequential or remote manual operation. It is interlocked so that only one blower at a time will operate and to prevent a telescopic unit from starting without adequate steam and water pressure. The individual blowers are controlled pneumatically; and the sequence operation is in direction of boiler gas flow, starting with furnace deslaggers, through the superheater, economizer and lastly the single nozzle mass blowers in the air preheaters.

Four Raymond No. 573 Bowl mills serve each boiler. The individual capacity of each mill is 26,500 lb per hour when grinding 55 Hardgrave scale coal, with a maximum of 8 per cent moisture, pulverizing to a fineness of 70 per cent through a 200 mesh sieve. The exhauster is integral type, driven directly through the mill and equipped with whizzer blades to lessen the wear on the exhauster blades. Star feeders driven by a Sterling Speed Trol control the coal flow to the mills.

The furnace is tangentially fired, with eight Type T burners per corner disposed in two banks of four each. Each pulverizing mill serves the same two burners in each corner, and all burners are so arranged that in combination with the by-pass damper, located between the boiler and the economizer, they control steam temperature.

Furnace Operation

To accomplish this, all burners and their auxiliary air nozzles are made adjustable in the vertical plane, plus or minus 30 deg. The top and upper center burners, and their air nozzles in diametrically opposed corners are tilted together by motor operation, while the lower center and bottom burners with their air nozzles, have manual tilt control, operated from each corner. The lower burners are set to maintain maximum turbulence to minimize sulphiding and maintain bottom temperature so that slag may run freely.

A change in outlet steam temperature may be effected by a change in either mass flow of the gas, or gas temperature, or both. A sensitive element in the outlet steam lead is set to maintain 950 F plus or minus 10 deg. Any variation from this temperature causes the damper to either open or close, changing the mass flow of gas across the superheater. Thus an increase in steam temperature causes the damper to open and by-pass part of the gas directly to the economizer without passing over part of the superheater surface. Conversely, closing of the damper causes more gas to flow across the superheater to raise steam temperature.

A change in steam temperature also causes the upper burners automatically to tilt either upward to increase steam temperature or downward to reduce temperature. The effect of the tilt is to cause the zone of active combustion in the furnace to raise or lower, decreas-

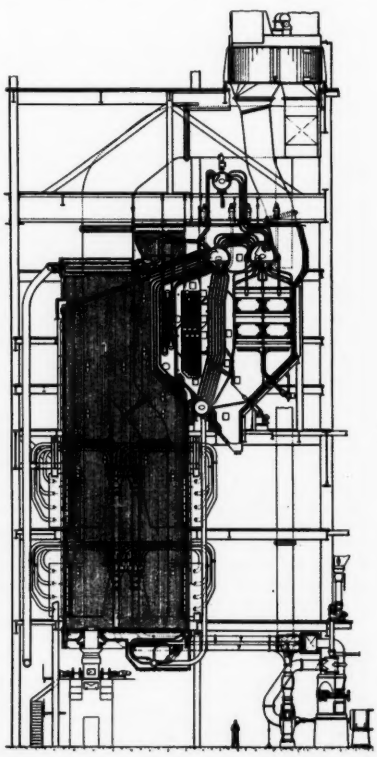


Fig. 4 Cross section of one of the high pressure units

ing or increasing the effective heat absorbing surface in the furnace, to increase or decrease the temperature of the gas entering the superheater.

In operation, it is expected that the damper will operate through a pre-determined angle, after which the burners will adjust themselves to the new gas temperature requirements, the alternate movement such that the damper position serves to bring the burner tilt mechanism back into its operating range. The damper operation thus increases the overall range of superheat control.

The flame from diametrically opposed corners will travel equal distances, but different from the other two corners. Therefore, in order to have the flame meet at the same elevation in the furnace, diametrically opposed burners are separately set in angular tilt.

In addition, a secondary control, based on change in air flow is employed to anticipate temperature change, causing the damper-burner control to over-travel or under-travel. The steam temperature element then operates to become the determining factor in the damper-burner control. Manual operation of the upper burner tilt and damper movement can be accomplished remotely from the control board.

In order to maintain as great a measure of safety as possible, and at the same time provide for the complete and instantaneous control of burners from the control board, the ignition has been arranged so that in starting a cold boiler, the control board operator gives permission to start to the burner operator by means of a signal light, push button operated. The burner operator then opens a pilot gas cock, which in turn energizes the spark plug and ignites the pilot. In addition, a circuit through both pilot and main gas cock solenoids is closed, opening the main gas cock. The operator can then manually open a gas valve in series with the main cock and obtain ignition on the torch from the pilot. The closing of the solenoid circuits however, transfers complete control to the control board operator and places instantaneous control for starting with a hot boiler, or to start or stop mills as required, with the board operator. When a boiler is shut down, the burner operator closes the pilot valve, which in turn closes the main gas cock by opening the solenoid circuit and transfers all control back to the burner operator. The main gas valve is then manually closed. There are four pilots and four ignition burners per corner, one each located between each pair of coal burners.

Coal enters the station from an existing conveyor system serving both stations. The conveyor inside Waterside No. 1 has been relocated to accommodate the new equipment, the air preheaters of No. 90 Boiler having been spread far enough apart to allow the belt to occupy space in the center of the station.

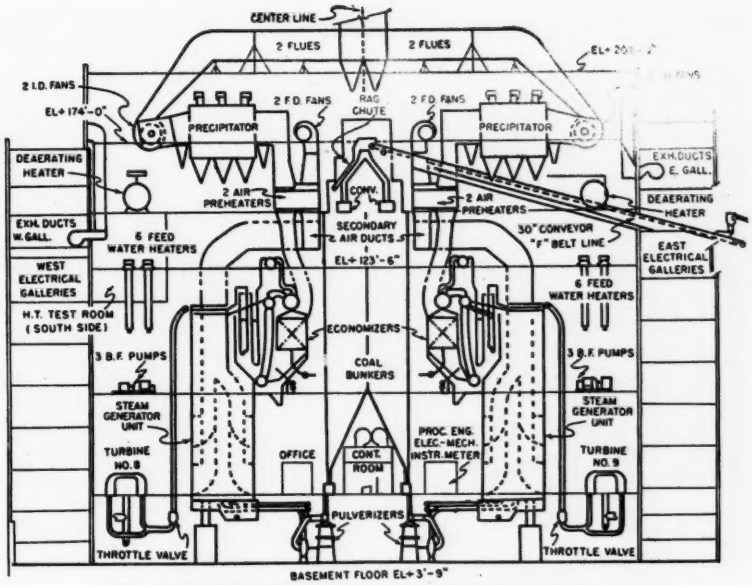


Fig. 5 Simplified longitudinal section through the boiler house

The coal bunkers are located in the center between the two boilers, and are long in the north-south direction and narrow in the east-west direction. Above the bunkers are two reciprocating conveyors running north and south in order to distribute coal over the long bunkers.

The main conveyor discharges to a hopper above these two reciprocating conveyors, and a bifurcated chute permits the feeding of coal to either of the two. The reciprocating conveyors are so arranged that they travel on tracks lengthwise of the bunkers and automatically trim the coal. Fig. 7.

Coal falling on either reciprocating conveyor from the bifurcated chute is discharged over the front end of the conveyor, which is in itself moving in the direction of belt travel. When the head pulley reaches the end of the bunker, a limit switch stops the travel of the conveyor carriage, and reverses the circuit after a slight time delay. At the same time, an arm and gear segment has mechanically reversed the position of a flap gate in the loading boot, allowing coal to fall directly into the center of the bunker for the period of time delay in order that

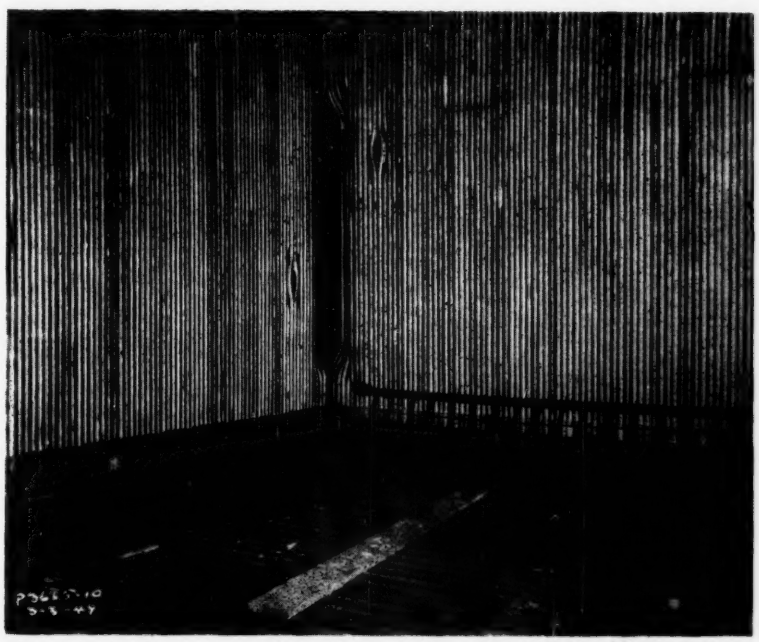


Fig. 6 Inside of boiler No. 80, showing floor of furnace, aluminized wall tubes and lower burner box

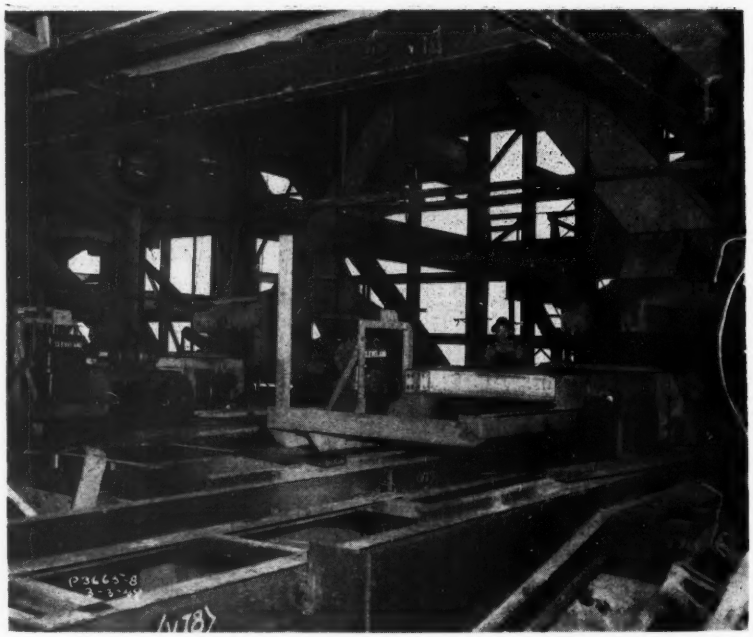


Fig. 7. Reciprocating Conveyors for Boiler No. 80 (right) and Boiler No. 90 (left)

complete trimming is accomplished. The time delay also allows the conveyor belt to continue to run until it can clear itself of coal. As the return travel of the carriage begins, the belt limit switch makes contact to reverse the direction of belt travel, and allow the belt to approach the falling coal stream and load in the direction of belt travel. Should the demand be heavy on any one section of the bunker, manual controls are provided so that the conveyor may be spotted to discharge to that section until level is restored.

Four Seco coal gates are located directly below the bunker openings. The coal downtakes between gates and mill feeders is short and vertical and is made as an expanding section in order to minimize coal hang-up in the down-take.

Two forced draft fans per boiler are American Blower Corp. Type

(Continued on page 114)

Principal Boiler Plant Equipment in Waterside No. 1 Topping Units

STEAM GENERATING UNITS 2—Combustion Engineering—Superheater, Inc., continuously slagging bottom furnaces with Elesco Superheaters, Elesco Economizers and Ljungstrom Air Preheaters. Steam generating capacity 925,000 lb per hr each at 1600 psig and 950 F continuously. Peak capacity 1,000,000 lb at 1600 psig and 950 F for 24 hr. Furnace and boiler 30,271 sq ft, superheater 29,720 sq ft, economizer 32,750 sq ft, air preheaters 260,000 sq ft of surface. Thirty-two burners, 8 per corner, firing tangentially, each adjacent pair served by a Raymond Bowl mill, No. 573. Each of the four mills and exhausters driven by a G.E. 300 hp, 440 v, 900 rpm motor. Four Raymond Mill Feeders driven by 1 hp 208 v, 900 rpm motor with Sterling Speed Trol having speed-range 10 to 40 rpm. Steam temperature control by damper and burner tilt through Leeds and Northrup control and Hagan temperature element.

PRECIPITATORS 1 per boiler consisting of 2 units each, manufactured by Research Corp., designed for 95 per cent removal when handling 460,000 cfm at 300 F. Each unit 33 ducts wide, three sections long, steel plate electrodes with 4 electrical sets each, operating at half wave, with switching provisions so that the last section may be operated on full wave.

INDUCED DRAFT FANS 2 Per Boiler—B. F. Sturtevant, Double Inlet, Double Width Design 3 Turbovane Size 1012 with erosion resistant wheels; floats self cleaning, partially forward curved with radial tip; water cooled bearings; designed to handle 265,000 cfm each of 295 F gas at 13 inches H_2O at 585 rpm.

INDUCED DRAFT FAN DRIVES—Each Fan Driven by a single totally enclosed 800 hp, 440 v, 585 rpm motor. On No. 80 Boiler, three operating motors and one spare furnished by Allis Chalmers. One operating motor, with Silicone insulation furnished by Westinghouse. On No. 90 Boiler, 4 Motors furnished by Allis Chalmers.

FORCED DRAFT FANS 2 per Boiler—American Blower Corp. Type HS No. 10, Double Inlet, Double Width Special, backwardly pitched blades; water cooled bearings. Each fan designed to handle 156,000 cfm of 120 F air at 15 inches H_2O at 1182 rpm.

FORCED DRAFT FAN DRIVES—Each fan driven by a single totally enclosed 500 hp, 440 v, 1185 rpm motor. On No. 80 Boiler three operating motors and one spare furnished by Allis Chalmers. One operating motor with Silicone Insulation furnished by Westinghouse. On No. 90 Boiler, 4 Motors furnished by Allis Chalmers.

FLY ASH HANDLING United Conveyor Corp. pneumatic system with loading points at precipitators, flue hoppers and stack, discharging to existing silos. Vacuum produced by 2 Nash L-8 Hytor Vacuum pumps each driven by a Howell 75 hp, 208 v, 900 rpm motor, with V belt drive, 900: 360. Remote automatic control for pump motors and motor operated water valve from control panel in boiler room arranged for automatic sequential and manual control; transport capacity 25,000 lb per hr from the inlets most remote from the pumps through 5 inches and 6 inches single Durite pipe line.

SLAG HANDLING SYSTEM 2 Slag Rakes per boiler consisting of two inclined pits with rake mounted above each. Each rake operates at 3 or 6 rpm and is driven by a two speed 3/1½ hp motor operating at 900/1800 rpm through a Universal speed reduction gear. Rakes discharge to detachable body cars for disposal at hoppers on dock. Motive power is 5 Ton Yale and Towne Electric Trucks.

COMBUSTION CONTROL Hagan Corp.—arranged to regulate the induced and forced draft fan delivery through vane control and the coal feed through Sterling Speed Trol to maintain steam pressure on each boiler.

FEED WATER CONTROL Bailey Meter—3 Element, operating feed pump turbine steam valves to maintain steam flow, water flow and water level for each boiler.

LEVEL INDICATION Remote by means of Yarway Level Indicator for each boiler, indicating in control room, and paralleled by Diamond Power Specialty Co. Utiliscope indicating both in control room and at feed pump turbine control panel.

CONTROL BENCH BOARDS AND PANELS—Light gray Formica covered plywood mounted on structural steel frame. Panel Boards, Bench boards and room panels by Schvetz and Hadeler Co. Structural steel frame by Craftsmen Welders Inc.

CHEMICAL FEED PUMPS Three Milton Roy Co. Simplex pumps for sodium phosphate each 32 gph at 2000 psig, 7/8 inch dia piston by 4 inch maximum stroke, with length of stroke variable, each driven by a 5 hp, 208 v, 3 phase, 60 cycle, 1750 rpm motor.

Three Lapp Insulator Simplex "Pulsafeeder" for caustic, each 15 gph at 150 with 1 inch dia by 1.6 inch stroke, 58 strokes per min, with length of stroke variable, each driven by ½ hp, 208 v, 3 phase, 60 cycle, 1750 rpm motor.

EXTERNAL FEEDWATER TREATMENT—Supplied by Belco Division of Bogue Electric Co. consisting of one Sodium and one Hydrogen Softening tank, one Salt and one Acid Regenerating tank, one degassifier, piping and controls and one Proportioneer Chemo-O-Feeder for pH control of water leaving the degassifier.

SOOT BLOWERS Vulcan sequential system on each boiler consisting of 26 furnace wall blowers, 10 rotary boiler blowers, 16 rotary economizer blowers, and incorporating in the control 6 water cooled Diamond telescopic blowers for screen (furnace side), 2 steam cooled Diamond telescopics for screen and superheater and a single mass blower of Air Preheater Co. design in each air preheater.

SAFETY VALVES—Superheater Header: 1-3" Ashcroft, Type 1525-D Power Control Valve, 2400 psi, 955 F and 3-4" Consolidated Type 1558-R.D., 2000 psi, 1000 F. Dry Drum: 7-4" Consolidated, Type 1558, RA, 2000 psi, 650 F.

Vaporization Cooling of Large Electrical Machines

Vaporization cooling — What it is; how it works . . . Water and steam as insulators . . . Advantages of vaporization cooling over conventional methods . . . Constructional features of vaporization cooled machines . . . Corrosion in vaporization cooled machines . . . Quantity of water required . . . Auxiliary equipment imposes no problems

VAPORIZATION COOLING of electrical machines is a New method of cooling, proposed by Theodore de Koning, in which the heat losses are removed by the evaporation of a liquid supplied in the form of a fine spray or mist. As explained by Mr. de Koning in a paper which he presented before the Winter Meeting of the American Institute of Electrical Engineers recently, this method of cooling has many advantages over the conventional methods now in use.

The principle of vaporization cooling is shown in Fig. 1. In this diagram, it is applied to a rotating electrical machine—a generator or a motor. The closed housing contains, from right to left, the supply tubes for the fluid (water), the stator and rotor, the thermostatic regulator and the condenser cooling coil.

The water sprayed into the air gap in the form of a very fine mist, absorbs heat from the surfaces of the machine and is thereby vaporized. The vapor passes into the condenser at the other end of the machine and is condensed by the condenser cooling coil, the entire shell being under vacuum. The condensed vapor collects in the lower half of the condenser and passes through a cleaning filter in the refillable water container at atmospheric pressure. The vacuum created in the condenser sucks the water mist into the air gap and by way of the thermostatic regulator into the condenser in the quantity needed for cooling. The regulator is operated by the vapor temperature. The air is removed by the vacuum pump.

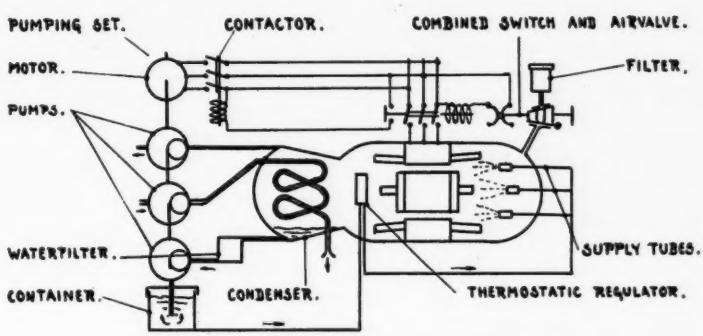


Fig. 1. The vaporization cooling scheme in principle

Water and Steam Good Insulators

The use of water in an electrical machine seems somewhat startling perhaps, yet as Mr. de Koning shows, water and steam, when properly applied, are better insulators than air or hydrogen. In air cooled or hydrogen cooled machines, water on the windings can cause damage because of through-wetting. A superficial judgment would attribute the same damage to vaporization cooling but a careful study of conditions in vaporization cooling shows that this is not true. Water absorption is next to impossible in a properly designed vaporization cooled machine. The electric disruptive strength of water is about twice that of air and in the mist stage, especially in the superheated vapor stage it is a good insulator. With a machine in service, water cannot penetrate the insulation and its surface is above the vaporization temperature. Out of service, air admitted through a valve and filter keeps the insulation dry. So at all times the insulation is kept in top condition.

With vaporization cooling, cooling takes place at constant temperature. This means that the insulation stresses over the core length will be equal. A sizable decrease in necessary surface or in insulation strain is the result. In an evaporating medium the temperature remains constant until the medium is fully vaporized. Since this holds at constant pressure only, the cooling temperature can be adjusted.

Since the cooling is limited to the air gap, the cooling fluid is equally and fully utilized; there are no dead corners, plugged passages or air vents. Vapor and fluid form a fog due to high rotor speed. A housing becomes superfluous. The end shields are small, sturdy and light. Vacuum pressures are desirable because of the small surface friction. For water at 0.8 psia vaporization temperature 34.2 C. one pound has a volume of 418 cu ft and absorbs 979.6 Btu. At 1.6 psia, temperature 47.3 C it has a volume of 214 cu ft and absorbs 962.5 Btu. One pound of air, on the other hand, has a volume of 13.6 cu ft and absorbs only 12.9 Btu with a temperature rise of 30 C.

With vaporization cooling, it is obvious, the cooling fluid must be finely subdivided. It can be broken up by rapid motion in the air gap,

The method of cooling electrical machines described in this article is as revolutionary as hydrogen cooling was in the early twenties. The orginator of the idea proposes nothing less than to spray water into the windings and air gaps of electric generators and motors. Startling as this may seem on first thought, it is not as silly as it sounds, indeed, Mr. de Koning proves in many ways that it is not silly at all. He not only advances the idea but shows exactly how it should be carried out. Water vapor and steam are better electrical insulators than air and with the method proposed very little of it would be needed. For a 50,000 kva machine only 40 gallons of water would be needed. This method of cooling was the subject of considerable discussion at the Winter Meeting of the American Institute of Electrical Engineers in New York where Mr. de Koning presented a paper on it. Since this is a rather revolutionary idea, we present this discussion of it here for further comment by readers. Naturally, a plan so revolutionary as this, involves many problems which will have to be solved before it could be brought to a commercial realization, but as Mr. de Koning indicates, none of the problems which impose themselves at this time seem incapable of solution

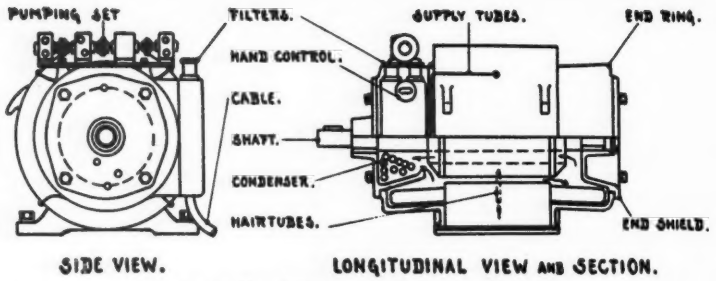


Fig. 2. A self contained vaporization cooled machine

by fluid streams hitting hard surfaces, by atomizing nozzles or other means. The smaller the fluid drops the larger their surface, and the easier it is for the vapor to free itself. Clean surfaces and the absence of air give good heat transfer.

A collection of fluid in the rotor is impossible, due to the centrifugal force; in the stator core it is practically impossible. The teeth tips are coolest, the teeth roots, hottest. Any fluid getting between the teeth and coils is soon stopped by the vapor it creates and is quickly dissolved. The same holds true for fluid trying to penetrate the insulation. The lowest temperature in the machine, excepting the condenser, is the air gap. Superheating by the end windings before condensation makes for an easy control, and insures against too much fluid being supplied. The specific heat of steam is about twice that of air. Only about 1/80th of the weight of air is needed, at full load.

The cooling fluid can be supplied through small radial channels (from the outer circumference to the air gap) in the stator core. Due to the absence of air vents, the nearly saturated vapor flows, with smoothly increasing speed, through the air gap toward the end windings. This reversal of the customary direction of flow and the increasing speed are of the utmost importance. The vapor speed midway between the exhaust rings (usually the core sides) will be zero. The flow resistance is therefore one-third of the resistance of a constant flow with exhaust ring velocity. With rotor surface speeds of 300 miles per hr and more, the axial component of the vapor speed, even if of say 60 miles maximum, increases the surface friction only about 3 per cent. From an aerodynamic point of view, vaporization cooling, compared with air or hydrogen cooling is in a class by itself.

Operating procedure with vaporization cooling is simple. The machine is put in service by the hand control, which closes the air inlet valve and the electric circuit. This circuit starts the machine and the pumping set automatically. As the vacuum space is small, the pump will create the required vacuum in a very short time. The machine is taken out of service by the hand control, opening the electric circuits and associated valve, which lets dry air in the machine.

With the exception of the thermostat between the rotor and the condenser, all auxiliary apparatus is mounted on the outside of the machine. Since the condenser can be located between the end windings and the outgoing shaft, the machine dimensions need not be increased, even for a condenser designed for large overload capacity. Figure 2 shows a sketch of such a machine.

Constructional Features of Machine

The stator core can be enclosed, airtight, in a frame cage, consisting of end rings and longitudinal bars, hollow for strength and for vapor-flow. Such an arrangement is shown in Fig. 4. The end rings and end shields can be externally and internally insulated to eliminate condensation, electric flashovers, etc. Since the laminated core is somewhat elastic in the axial direction, the balancing expansion coefficient and temperatures of the conductors and bars will reduce the relative movements of core and conductor insulation.

Since the windings are well protected on all sides in the cores, the cooling fluid is best applied at the air gap. Hair tubes can be led through, and sealed in, radial channels in selected groups of laminations.

The sprayed water droplets will be thrown and flattened against the rotor and move over it, cooling the surface, until they have attained nearly the velocity of the rotor. What remains of the droplets is thrown against the stator, cooling the punching teeth and the wedges.

The rules for applying vaporization cooling differ from the rules for air cooling and hydrogen cooling. The quantity of cooling medium depends only upon the heat it must remove.

With constant fluid regulator setting, the pressure difference between the supply and vacuum determines the fluid volume. An instantaneous fluid reduction, and a surface temperature rise, are therefore the result of a vacuum breakdown. If the vaporization temperature (vacuum pressure) increases, the temperature difference for the removal of the heat of the windings decreases. In time, temperature gradients and maximum temperatures increase, with no reduction in load. This makes it difficult for the fluid to penetrate and damage the insulation.

The exposed end windings are cooled by clean, almost dry vapor instead of by the wettest and dirtiest gases as in the case with air cooling. No surface damage can therefore be caused by creapage. The disruptive strength of water is 56.5 kv compared to 25.0 kv for air with a 1 cm gap. The resistance of water is about 4×10^{-8} ohms per mm^3, of petroleum 3×10^{-13} ohms per mm^3. In the mist state and especially in the superheated vapor state, the resistance will be quite satisfactory.

A resistance-temperature curve taken of hygroscopic paper fiber is instructive. This is shown in Fig. 5. It shows a dangerous cleft in the curve between 50 and 100 C with a low of about 80 C. The explanation is that only when the vapor tension approaches the atmospheric pressure at 100 C. can the moisture be expelled.

In vacuum machines, the vaporization temperature (at 1 psia, 100 F) is near the lowest temperature the machine will assume in or out of service. Also water absorption is next to impossible. The insulation remains in top notch condition over the entire temperature range. Even with water absorption, the cleft has become a hump for the insulation temperatures of the machine in service. All this fully justifies a smaller insulation thickness. The electrical insulation value increases rapidly with a decrease in thickness;

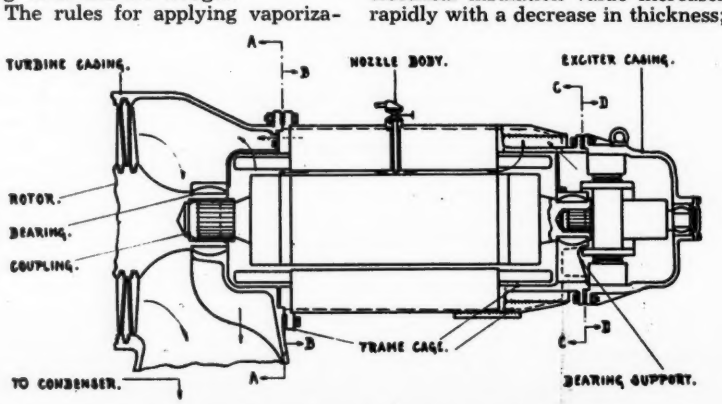


Fig. 3. Longitudinal section through a vaporization cooled generator

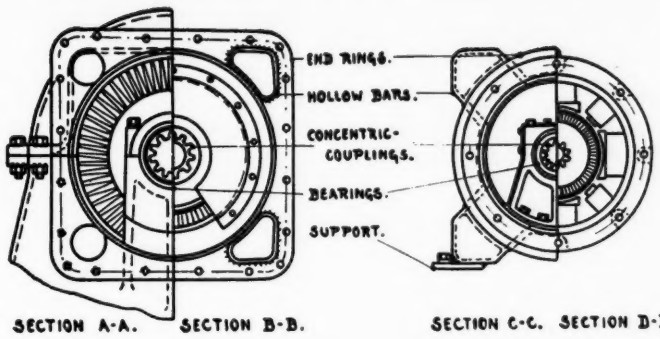


Fig. 4. End view of machine shown in Fig. 3

for example, mica 1 mm, 50 kv per mm; compared to 150 kv per mm for mica 0.1 mm thick.

Corrosion in Vaporization Cooled Machines

The oxygen dissolved in water that comes in contact with metal surfaces can cause corrosion and under certain circumstances, erosion. The rate of corrosion is influenced by the number of water molecules coming in contact with a unit of surface. This number is small for vapor in a vacuum. Take note that corrosion products and impurities can absorb moisture at humidities down to 65 per cent and form an invisible water layer. This can easily be prevented in a closed cooling system. Moreover, the critical surface temperatures are always above the dewpoint (vaporization temperature).

Furthermore, superheated water released under vacuum pressure explodes and liberates about 95 per cent of the air it contains. Hence, the oxygen will hardly come in contact with the rotor surface. It need not come in contact with the stator surface for the vaporizing water will act as a shield. The small quantity of fluid needed to remove the heat losses, the high maximum closed cycle speed possible, the continuous removal of air by the air pump and of impurities by the filter, all assist in keeping the water at high purity and the desired alkalinity to inhibit corrosion. The treated boiler feedwater used in high-pressure steam boilers can be used.

Quantity of Water Needed

The total quantity of water needed for a 50,000 kva machine with 2 per cent losses, operating continuously for a year, using vaporization cooling is low. Assume a rotor core surface of 70 sq ft. Assume the average heat losses reduced to full load losses equal to 1/3 of the hours in a year. Then, the core surfaces have to evaporate 20,000 gal per sq ft per yr. With a full load cooling cycle speed of 6 minutes, only 40 gal of water are needed. With the water added each year we can calculate the total solid water content, which, obviously, is negligible.

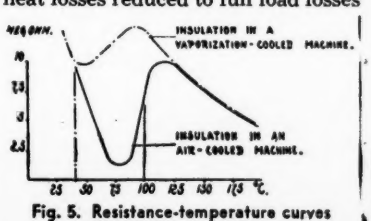


Fig. 5. Resistance-temperature curves of hygroscopic insulation

Conclusion

Mr. de Koning expects that the proposed vaporization cooling system will have the following advantages over present cooling systems:

1. A saving of 5 to 15 per cent in copper and punching volume without increasing the current densities or the flux densities.
2. A slightly better efficiency, improved simplicity, a saving of 25 per cent or more in weight, and a saving of 15 per cent in the cost of large machines.
3. Just as hydrogen cooling cuts the space needed for air cooled units in half, so will vaporization cooling cut the space needed for hydrogen cooled units.
4. Filling or exhausting the machines becomes a matter of minutes instead of hours. Painstaking supervision is not needed, and the yearly outlay for lost hydrogen and scavenger gas can be saved.
5. The machines are suitable for any size and environment and for any constant or variable speed. There is a saving in housing, end shields, shaft seals, bearings, couplings, etc.
6. The auxiliary equipment for the cooling is already in wide use, its cost is small, and it can be used in part for all of the machines in a particular installation.

It must not be assumed that there will be no problems to overcome in bringing a system such as this into commercial use. A new type of design always requires a lot of work of a most exacting nature. As to structural simplicity, any improvement in some part is usually offset by a complication in other parts.

Experience proves, however, that the things which cause trouble in practice hardly ever are the ones which were feared in the beginning. These usually proved to be much overrated. Experience with hydrogen-cooled machines bears this out. Damage to insulation and explosion danger proved, later, to be little more than scares. Hydrogen leakage and hydrogen contamination, however, made many design improvements desirable.

SELECTING POWER CABLES—CORRECTION

ATTENTION IS directed to several errors in the article "Selecting Power Cables to Meet Short Circuit Requirements" by R. H. Kaufman, on page 64 of the February issue.

The formulas at the top of column 1 on page 65 should appear as follows:

$$\left(\frac{I}{cm}\right)^2 t = \frac{1}{33} \operatorname{Log}_{10} \frac{(T_2 + 234)}{(T_1 + 234)}$$

$$t = \frac{1}{\left(\frac{I}{cm}\right)^2 (33)} \operatorname{Log}_{10} \frac{(T_2 + 234)}{(T_1 + 234)}$$

On page 66, in the last sentence of the second paragraph in the center column, the parenthetical expression should read —(75 — 150 C basis)

At the top of page 67 in the center column the quantity which appears as $\frac{143^2}{185}$ should read $\left(\frac{143}{185}\right)^2$.

IMMEDIATE MEDICAL ATTENTION IN SOLVENT ILLNESS

WORKERS HANDLING volatile solvents should be instructed to report promptly any feeling of discomfort. Dizziness, headache, eye difficulties, weakness, nausea, or stomach upset may be due to other causes, but they can also result from inhaling solvent vapors and may serve as an early warning that medical attention is required. Neglect of such warnings may lead to serious illness.

In one instance, a man spent several hours cleaning some equipment with a substantial quantity of solvent in a basement room where there was little ventilation. Several times he felt a little dizzy, and went outdoors for a few breaths of air and to get away from the odor. Since this made him feel better, he said nothing about his discomfort but kept at the job until it was finished. The next day he felt much worse and, by the time he consulted a doctor, he was seriously ill and had to be sent to the hospital.

In another case, a man entered a solvent tank to clean it, and made the serious error of not using a respirator. He became ill from the heavy solvent fumes and, instead of reporting to a physician, tried to treat himself by taking a few nips of hard liquor. A doctor would have told him that alcohol intensifies the effects of solvents on the body. His self-treatment led to serious illness.

Some persons are especially susceptible to solvent illness, and even a rather mild exposure (degreasing a motor or wiping metal parts with a solvent-saturated cloth,) may lead to illness.

Simplify Your Calculations for Air Compression and Humidity

By WILLIAM T. RICE
Application Engineer
Worthington Pump & Machy. Corp.

IN APPLYING compressed air to various processes, limitations that these applications place on the permissible moisture content of the air demand a careful analysis of the compression system. Effect of humidity on the performance of the compressor itself is also important.

To establish completely a condition of air on the accompanying chart, the temperature, pressure, and relative humidity must be known. The quantity most difficult to measure is the relative humidity. If the pressure is substantially close to the standard pressure of 29.92 in. Hg, a psychrometer and psychromeric charts can be used to determine the relative humidity. A much simpler method employing the chart is available if a dew point indicator is used. Horizontal lines on the chart are locuses of constant dew point temperature. Dry bulb temperatures at 100 per cent relative humidity are equal to the dew point temperatures. Therefore, a dew point temperature line of, say, 110 F is drawn horizontally through the intersection of the 110 F dry bulb temperature line, and 100 per cent relative humidity. The intersection of a dew point line with a dry bulb temperature line will indicate the relative humidity. The intersection of a dew point line with a pressure line will completely define the state. Then the capacity correction factor, the specific gravity of the moist air, and the pounds of moisture per pound of dry air can be read directly from the chart.

Many industrial users of compressed air require a definite rate of flow of dry air. The moisture may be condensed before it reaches the process or the water vapor may not take part in it. In any case the capacity of moist air required should be determined for a desired capacity of dry air, or vice versa. For this reason a capacity correction factor F has been shown on the chart. This factor will determine for some stated number of cubic feet per minute of dry air, at a given temperature and pressure, the corresponding number of cubic feet per minute of moist air at the same temperature and pressure, and a stated relative humidity. The situation is expressed mathematically in Equation (1). It is important that both capacities be measured at the same temperature and pressure.

Performance of centrifugal compressors is often determined by referring to the adiabatic head developed. Computations to determine the adiabatic head required to compress air are usually based on the assumption that the air is dry and at a specific gravity of 1.00. The head required to compress moist air can be simply determined by dividing the head computed for dry air by the specific gravity of the humid air. This is expressed in Equation (2).

Determination of the total weight of moist air is considerably simplified by the use of specific gravity values.

Specific volume of moist air equals the specific volume of dry air, at the temperature and pressure of the moist air, divided by the specific gravity, Equation (3). Weight of moist air per minute equals the flow of moist air in cu ft per min, divided by the specific volume of moist air, Equation (4). Weight of dry air passing through the system can be computed in two ways, as in Equation (5).

Horsepower Requirements

Since the weight of moist air and the head required to compress it have already been determined, the most obvious method of solution for adiabatic horsepower is the first expression in Equation (6).

Therefore, the adiabatic horsepower required to compress dry air will be the same as the power required to compress dry air mixed with water vapor at the same volume rate of flow, temperature, and pressure. This process should not be confused with "wet compression" where the air is maintained saturated throughout the compression and there is a reduction in horsepower required. It must be recognized, however, that where water vapor is condensed between steps of compression (as in intercoolers), the mass flow will be reduced by the amount of condensation. The horsepower requirement of compressors following coolers should be determined on the basis of the reduced flow.

Moisture Condensed

On the chart, at any state, the weight of water vapor per pound of dry air is indicated. The pounds per minute of dry air passing through the system has been calculated (Eq. 5) and, of course, for all practical purposes remains constant throughout the compression process. The amount of water vapor present at any point in the process can be calculated readily by Equation (7).

If condensation takes place in an inter- or aftercooler, the relative humidity will be 100 per cent, that is, the air will be saturated with water vapor. Knowing the pressure and temperature in the cooler and assuming 100 per cent relative humidity, the quantity of moisture per pound of dry air can be determined from the chart. By substituting in Equation (7), the maximum weight of water vapor in the air discharged from a cooler can be determined. In most coolers this will be less than the weight of the water taken into the compressor and the difference in weights will have been condensed. This calculation performed on the aftercooler will yield the weight of moisture in pounds per minute entering the air distribution lines. An analysis of this sort is as important to those checking existing plants as to designers determining the most economical operating temperature in coolers.

Other Uses

For those interested in dehumidification of air by compression, the pressure and temperature to which the atmospheric air must be compressed and cooled can readily be determined from this chart for a stipulated final relative humidity. A check on the effectiveness of moisture removal by inter- and aftercooling can be made by calculating the amount of moisture condensed and measuring the flow of condensate from the coolers and receivers.

This discussion and the chart pertain strictly to mixtures of air and water vapor, and cannot be extrapolated to other mixtures.

Table I. Equations and Nomenclature

1. $Q_m = FQ_d$
2. $Ha_m = Ha_d \div S.G.$
3. $v_m = (0.37 \times T_1) \div (S.G. \times P_1)$
4. $W_m = Q_m \div v_m$
5. $W_d = Q_d \div v_d = W_m \div (F \times S.G.)$
6. $AHp = W_m Ha_m \div 33{,}000 = (Q_m \div v_m) Ha_m \div 33{,}000 = (Q_m \div v_d) Ha_d \div 33{,}000$
7. $W_w = w_m W_d$

Here, Q_m = cu. ft. of moist air; Q_d = cu. ft. of dry air; F = capacity correction factor, from chart; Ha_m = adiabatic head of moist air, feet; Ha_d = adiabatic head of dry air, feet; S.G. = specific gravity (dry air = 1.00); v_m = specific volume of moist air, cu. ft. per lb.; v_d = specific volume of dry air at temperature and pressure of moist air, cu. ft. per lb.; T_1 = temperature of moist air, deg. F. abs.; P_1 = pressure of moist air, psia.; W_m = weight of moisture in moist air flowing, lb. per min.; W_d = weight of dry air flowing, lb. per min.; AHp = adiabatic horsepower; W_w = lb. of water vapor per min.; and w_m = lb. of water vapor per lb. of dry air, from chart.

Table II. How to use chart—an example

A plant requires 15,000 cfm of dry air at standard conditions of 60 F. and 14.7 psia., to be compressed to 100 psia. The initial conditions are: relative humidity, 90 per cent; inlet pressure, 13 psia.; temperature, 84 F. Air from the aftercooler is saturated at 75 F. and at a presssure of 100 psia.

From the chart (following the dashed lines) for the inlet conditions, D.B. Temp. = 84; R.H. = 90 per cent; pressure = 13 psia.; F = 1.0412; w_m = 0.026; and S.G. = 0.985. Similarly, in the aftercooler, D. B. Temp. = W.B. Temp. = 75; pressure = 100; and w_m = 0.003.

Then, capacity of dry air at inlet conditions = 15,000 × (14.7 ÷ 13) × (544 ÷ 520) = 17,740 cfm. By Eq. (1), capacity of atmospheric air required = Q_m = 1.0412 × 17,740 = 18,480 cfm. By Eq. (3), specific volume of moist air = v_m = (0.37 × 544) ÷ (0.985 × 13) = 15.72 cu. ft. of moist air per pound. By Eq. (4), weight of moist air = W_m = 18,480 ÷ 15.72 = 1,175 lb of moist air per min. By Eq. (5), weight of dry air = W_d = 1,175 ÷ (1.0412 × 0.985) = 1,145 lb of dry air per min. Then, weight of water entering the compressor = 1,175 − 1,145 = 30 lb of water per min, or W_w = 1,145 × 0.026 = 30 lb water per min. Finally, from the initial and final water content of the air, weight of water entering the compressor = 30 lb per min, as shown; weight of water leaving the aftercooler = 1,145 × 0.003 = 3.44 lb per min and weight of water condensed = 30 − 3.44 = 26.56 lb per min.

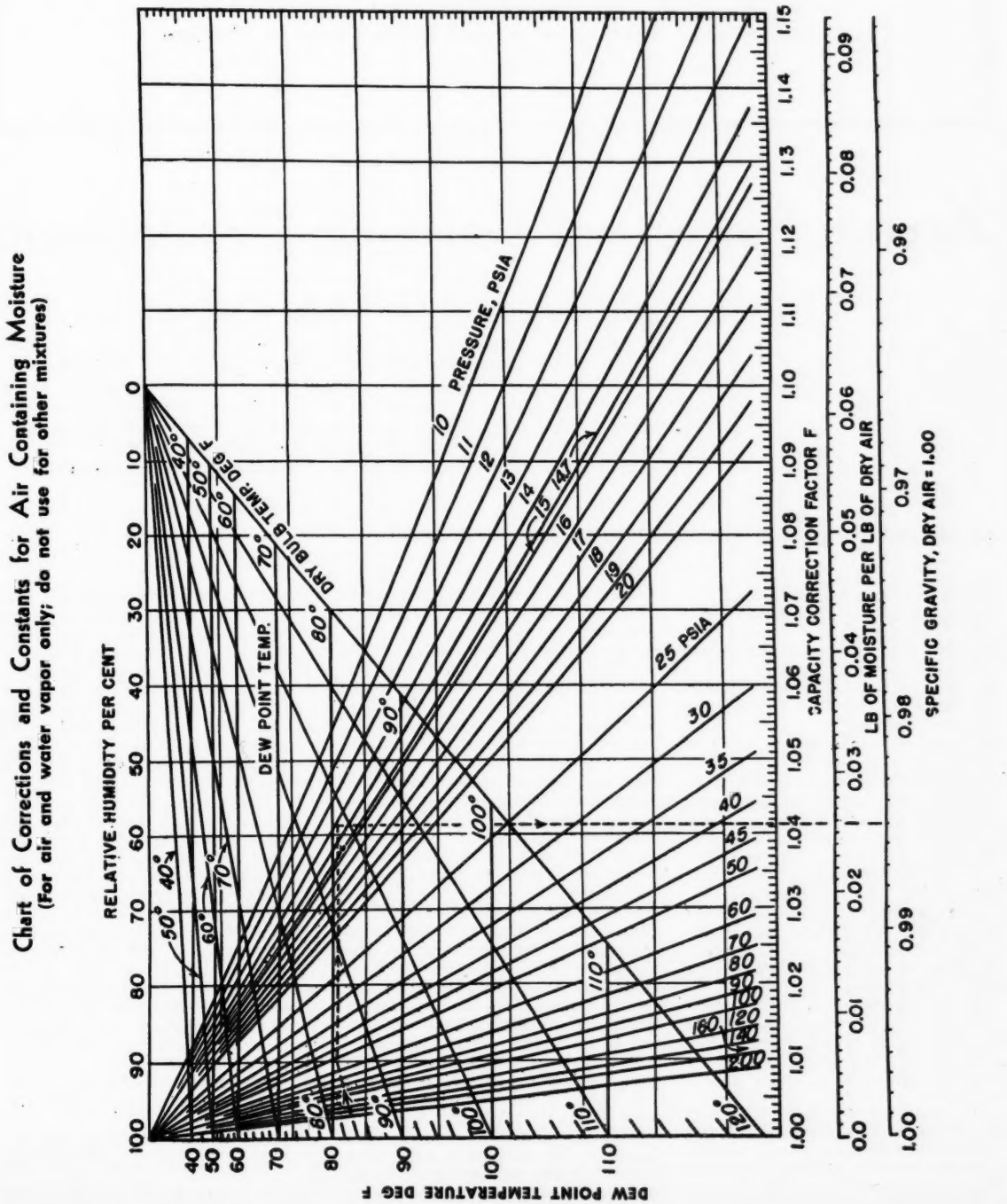


Chart of Corrections and Constants for Air Containing Moisture
(For air and water vapor only; do not use for other mixtures)
RELATIVE HUMIDITY PER CENT
DEW POINT TEMP.
DRY BULB TEMP. DEG F
PRESSURE, PSIA
CAPACITY CORRECTION FACTOR F
LB OF MOISTURE PER LB OF DRY AIR
SPECIFIC GRAVITY, DRY AIR = 1.00
DEW POINT TEMPERATURE DEG F

ATOMICS

A New Section added to POWER GENERATION to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

Atomic Power and Economic Development

This is essentially a condensation of an article by Walter Isard and Vincent Whitney which appeared recently in the Bulletin of Atomic Scientists. In this article the authors take issue with the views on the economic aspects of the development of atomic power expressed by Professor Blackett in his much discussed book, Fear, War, and The Bomb. Isard and Whitney do not feel that the development of atomic energy for power will suddenly enable have-not or backward nations to become strong economically and industrially. Walter Isard is Associate Director of the Teaching Institute of Economics, the American University, Washington, D. C. Vincent Whitney is Associate Professor in the Department of Sociology at Brown University.

By ANDREW W. KRAMER Editor, Power Generation

THE PUBLICATION of Professor P. M. S. Blackett's *Fear, War, and the Bomb*[1] points up sharply the inadequate attention which social scientists have paid to the implications of atomic power. As indicated by Walter Isard and Vincent Whitney in an article on this subject in the March issue of the Bulletin of the Atomic Scientists[2] in particular, the summary of existing analyses of the economic consequences of atomic power found in Chapter viii (Power from Atomic Energy) makes it embarrassingly clear that so far we lack a clear understanding of the processes involved in regional economic development and the general techniques which would enable us to analyze the effect of technological change on specific economics.

In any evaluation of atomic energy a factor of primary importance is the question of cost. Both social and natural scientists, among them Professor Blackett, generally incline toward an unwarranted optimism about the competitive cost of atomic power.

The only authoritative report on costs which has been made so far is that contained in the Thomas report issued in September of 1946.[3] This report stated that a power plant designed along lines then indicated and producing 75,000 kw could be built at a cost of around 25 million dollars. Assuming 100 per cent capacity operation and interest charges of 3 per cent on the investment, such a plant would deliver power at a cost of approximately 0.8 cents per kwh.

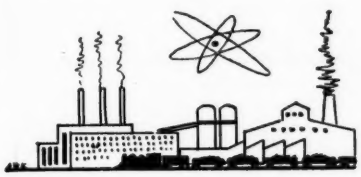
Since existing steam stations operate at their highest levels at 80 per cent of capacity and on the average only at 50 per cent it is obvious that the figures for the theoretical plant in the Thomas report should be adjusted to take into account the actual operating levels. When this is done, the Thomas figures become about 0.94 cents per kwh at 80 per cent capacity and 1.45 cents at the 50 per cent level.

It is instructive to compare the figure of 1.45 cents with figures by Schurr[4] in the accompanying Table for the cost of generating electricity in steam stations in various areas. These figures seem to indicate that it would be difficult for atomic energy to compete with conventional power sources even in countries where fuel is scarce. The same relations hold when atomic power is compared with hydroelectric power. Hydro costs range from 0.05 to 0.4 cents per kwh. Here the plant factors run higher so it would be more reasonable to use the 0.94 cent figure suggested for the Thomas plant.

Another report, issued after the Thomas report, was the California Report[5] presenting data on a system involving primary and secondary reactors. The suggested power costs for such a system vary from 1.1 cents per kwh with a 20,000 kw secondary pile and 0.75 cents with a 100,000 kw secondary pile to 0.4 cents with a 500,000 kw primary pile. In each case a 50 per cent plant factor is assumed. These cost estimates, however, are highly speculative since the figures are not based on the experience of actual pile operation. The value of these estimates

[1] Fear, War, and the Bomb, By P.M.S. Blackett. Whittlesey House, McGraw-Hill Book Co. 1949.
[2] Published monthly by the Atomic Scientists of Chicago, 1126 East 59th Street, Chicago 37, Ill.
[3] Will an Atomic Power Plant Pay? By C. F. Wagner and J. A. Hutcheson POWER PLANT ENGINEERING, Page 118, October 1946.
[4] Economic Aspects of Atomic Energy as a Source of Power, By Sam H. Schurr, Bulletin of the Atomic Scientists, Page 117, April-May 1947
[5] Atomic Energy: Its Future in Power Production, J. B. Condliffe, et. al., *Chemical Engineering*, October 1946, pages 125-133

is less in the absolute cost figures cited than in the suggestion that the operation of increasingly larger piles will permit a decline in costs. This assumption is reasonable since a sizable portion of the capital cost of the atomic power plant will be invarient regardless of size. Complicated control equipment, for example, should cost about as much for a small pile as for a medium or large pile. This is a point that Professor Blackett does not discuss nor do



others, yet it is a factor of first importance in the probable unequal development of atomic power.

Atomic Power Costs Still Speculative

Until the first atomic power plant has been built and in operation for a period of time, all cost figures must remain in the realm of speculation. Yet since such favorable estimates of atomic power costs lie behind the reasoning of Professor Blackett and other scientists it becomes necessary to examine the economic effects which atomic power might well exert if it were to become cheaper than conventional methods of producing power.

Of great importance, is the possible effect atomic energy would have on the location of industry. In general terms, industry may be divided into broad and overlapping categories based upon the importance of fuel consumption relative to other location factors.

Obviously, the development of atomic energy would have little effect upon the location of industries such as leather, in which fuel consumption is inconsequential; or upon those such as bakeries, which must remain close to consumers regardless of power costs or upon those such as paper and pulp products, which consume relatively large amounts of power but which are oriented to materials or markets. Two categories remain to be examined: those in which fuel and power constitute the major locational element, but where location of markets and raw materials is also important; and those in which the location is overwhelmingly a function of power.

The major electroprocess industry, aluminum, is an example of the last group. Here power requirements have drawn processing plants to cheap water power sources even though these have not been near the sources of raw material, bauxite. Twelve per cent of the total cost of manufacture of pig aluminum is accounted for by the cost of transporting bauxite.

Effect of Atomic Power on Aluminum Industry

It might be thought that with atomic power, the aluminum industry might consider relocating plants nearer the source of raw materials. To do so atomic power would have to match roughly the present hydro power costs of 0.2 cents per kwh. As long as atomic power costs remained some 0.12 cents per kwh above hydro costs, however, any saving in transportation costs would be more than wiped out by the higher power costs.

The iron and steel industry is another industry in which fuel and power are important but where location must at the same time be related to raw materials and markets. Atomic power might make it desirable to relocate steel plants near ore sites but a great part of the world's iron and steel industry is already located close to ore sites. In the United States there is a band of concentration of heavy industry, dominated by iron and steel stretching through the Appalachian coal fields and along the Great Lakes waterway system, the whole bound together by a relatively complex and efficient transportation system. It is unlikely that cheap atomic energy would do much to change this picture.

Such considerations do not necessarily apply in other areas of the world. Russia's rapidly growing Magnitogorsk area, for example, pays heavy transport charges for coal from the Kuznetsk basin some thousand miles distant. Potentially, the development of atomic power would be of especial importance in the continued expansion of such a strategic area. Other examples could be cited but the overall number is not large. Thus the possibilities of great changes that might be brought about by cheap atomic energy are easily exaggerated, particularly those related to decentralization of industry.

Table Showing Cost of Power in Various Areas of the World

Country	Cost per KWH in Cents, 1937	Cost per KWH in Cents, 1947
Argentina	0.9 to 1.1	1.6 to 1.8
Great Britain	0.725	0.95
India	0.65 to 1.0	.....
Soviet Union (Urals)	0.65	.....
United States	0.55 to 0.875	0.575 to 0.95

ATOMICS

Economic factors, of course, do not operate in isolation. Undoubtedly large piles will be constructed for political and military reasons and dispersion of industry may be dictated as a function of defense. On economic grounds, however, the result of the introduction of atomic energy might well be, not decentralization but increased concentration of industry and population.

It is well known, too, that a saving in fuel cost is not necessarily related to the economic welfare that derives from an industry. In the United States, the cost of fuel plays a relatively small part in the ultimate cost of power to the consumer. Rather, welfare increments occur through the application of more power consuming machinery per worker.

Relation of Atomic Energy to Existing Energy Resources

It might be assumed that the measure of the long run effect of the development of atomic energy is the existing potential energy reserve of the areas of the world involved. In the absence of other factors this would be quite valid but other factors may easily outweigh the advantage of cheap power. Professor Blackett refers to India. Here is a country whose energy endowment is fairly good. Yet, as the professor points out, her per capita energy production is low. This is not because she is taxing her energy resources but because there are resist-

ances of a most complex nature centered in her cultural heritage and in religious influences, both of which are related to her awesome population potential. Thus India's existing potential energy resources are to a large extent unrealized. Professor Blackett does not appear to take these stubborn cultural resistances into account when he suggests that as between India, the United States, the Soviet Union, and the United Kingdom, India stands to gain most in the long run from the technological developments which promise additional supplies of energy. It seems unlikely that the addition of a new source of energy, atomic energy, will stimulate an economic renais-

(Continued on page 92)

The PRACTICAL ENGINEER

DEVOTED TO PLANT OPERATION and MAINTENANCE

A. W. KRAMER, EDITOR

Wood-Metal Packing for Boiler Feed Pumps

By WILLIAM L. THOMAS

MOST ENGINEERS will agree that boiler feed pump service is considered to be one of the most difficult as far as packing is concerned because the hot water has a drying effect on the packing. This causes much more rapid deterioration of packing than steam or cold water. For this reason, engineers have exercised great care in the choice of packing that can withstand the drying-out inherent with this type of service.

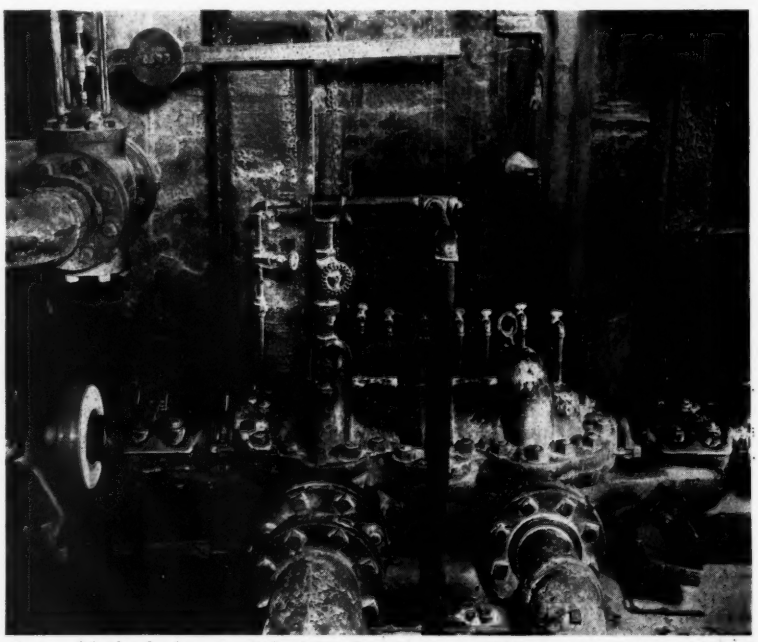
Among many excellent packings that have been developed for boiler feed pump service one which has given especially good service is wood metal packing developed by Robert H. Rains of Spokane, Washington in 1921. A DeLaval boiler feed pump at the Seattle steam plant of the Puget Sound Power & Light Co. packed with this type of packing in 1927 is still in service today. One ring of packing is added on the average of each four years. Formerly this pump, shown in the accompanying photograph, had to be repacked completely three times a year. This pump delivers 750 gpm at 2325 rpm with a 550 ft head with water at a temperature of from 180 to 200 F. It uses bronze sleeves.

The Rains Wood Metal packing used in this pump is made up of wood and metal units. A soft wood is used, native to the Pacific northwest, cut into long strips, which, in turn, are run through a cutting machine to obtain all shapes and angles. These units of wood are then segregated into various sizes for different packing requirements, placed in large vats and then undergo a treatment in specially selected and prepared oils and chemicals.

To give the packing long life, a lead base metal is used (Bunker Hill & Sullivan Lead). This is alloyed with certain other metals which produces an alloy soft enough, yet tough. These two basic materials, wood and metal, are thoroughly mixed, taking the correct proportions of each in volume, retreated and placed in cloth containers for ease of installation. The packing is never compressed into rings in the factory, but is always installed in the loose form to allow the units to move freely and to move readily to conform to the shape of the rod or shaft as pressure is exerted by the gland. The cloth container wears away immediately with a few revolutions of the shaft or reciprocating strokes as the case may be.

The wood units of the packing acts as storage reservoirs of lubrication, and also acts as spacing blocks to prevent the metal from ever forming a solid in the stuffing box after years of service. After the packing is used for a period of time, a bearing-like service is created, which cuts down friction of the rods or shafts to practically nothing. Because of this lubricating quality contained throughout every square surface element of the packing, during its many years of continual service, it has never been known to score a steel rod or shaft, except in cases where there was a whip or improper installation of the rods or shafts.

The use of boiler compounds in connection with boiler feed pump service, as any engineer knows, often



De Laval boiler feed pump of the Puget Sound Power & Light Co. steam plant at Seattle which has been packed with wood-metal packing since 1937. One ring of packing is added on an average of each four years. Formerly, this pump was repacked three times a year

has destructive effect on packings. Some compounds are more destructive than others. The building-up tendency of the compounds becoming imbedded in the packing causes serious abrasion of the shaft or rod, and each engineer must study very carefully the type of compound being used to avoid such consequences.

The lubrication built in and retained in Rains Packing gives it an outstanding advantage in withstanding the severity of boiler feed pump service. While this service will naturally dry the packing more than ordinary services will, the years of continuous operation of this wood-metal packing on boiler feed pumps speaks well for the packing. As mentioned before where rods and shafts with the use of other packing had to be changed every two to three years, they are only in a highly polished condition after eight and ten years of service.

Greetings From Oscar

Another episode of Oscar, the Gas Works Owl. He sees all, hears all and knows all.

By JOHN RAVEN

EVEN IN the gas works, where anything can happen, I have never shown anyone the note from Oscar, the Gas Works Owl. I found it on my desk the morning I came back from an engineering convention, and after putting into legible English the hen-scratchings Oscar makes with his claws and my overturned India ink, I destroyed the original. Here is my translation of the startling message:

Greetings: Yesterday morning (wrote Oscar) that young assistant of yours named George, was walking alongside the water-gas house and found a couple of iron plates turned back from the pipe tunnel that runs under the pavement. A dim light from the opening showed someone was down there, and being your assistant George figured he ought to know what was going on, so he leaned over the hole and yelled, "who's down there?" but got no reply. This seemed odd if not peculiar, so he dropped down into the tunnel and sure enough there was Pipenose Henry lying like dead in the glow of his own flashlight.

George dragged him out and with some help got him onto a cot in the gas works hospital. He came to a few minutes later and started yelling that Gus, the pipe-shop foreman, had tried to murder him.

"I was re-packin' an oil line valve, just like Gus told me," said Pipenose, who is said to look that way because he's been a steamfitter all his life, "and Gus crept up behind me and slugged me on the head. He don't like me and I want him hung. Call the cops."

—dragged him out

"Not so fast," said the doctor, "Did you see him do it?"

"Of course I didn't" said Pipenose scornfully. "He sneaked up behind me, didn't he? Besides the temperature in that tunnel must be 150 deg and my eyes were full of sweat. I couldn't hear him comin' either with steam hissin' and the danged traps clankin' like gears with their teeth out. If you was any good as an engineer," he added pointing a finger disgustedly at George, "you'd keep all that water out of your steam."

Pipenose started yelling

The doctor took George aside for a couple of whispers.

"There's a lump on the back of his head like a goose egg. Probably backed into something and got a slight concussion which makes him imagine things. Come back at noon and I think he'll be OK."

However at noon old Pipenose was demanding action louder than ever and the big boss (Oscar's note continued) stepped in.

"George," he said, "You got to settle this murder squawk right away. We don't want the cops in here, it would give the gas works a bad name."

So George went out to ask questions and the Boss figured everything was taken care of, with both of them showing that engineers avoid thinking whenever possible since talking and walking around are easier.

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"I wasn't in the tunnel this morning and I didn't slug him," said Gus when George cornered him in the pipe shop. He was a big Swede with yellow mustaches that he wiggled angrily. "I sent him into the tunnel because I figured he'd find it too hot to sleep there. That Pipenose is a loafer, and I oughta fired him long ago."

George went back to the hospital and the doctor began whispering. He was always whispering.

—with a sword, a pistol and a length of 2-in. pipe

"Why don't you bring Gus in here and let them face each other," he piped. "Some people believe the wounds of a murdered man will bleed again in the presence of the murderer. Tell it to Gus,—maybe you'll scare him into confessing."

Pipenose hadn't done any bleeding at all, and he surely wasn't murdered, but since walking and talking are easier than thinking, George towed Gus into the hospital.

For a minute the two of them just looked at each other, then Pipenose started yelling at the top of his lungs for at least a Stilson wrench so he could defend himself, and between yells he put in a few bids for the police.

"You no-good bum," shouted Gus right back, getting mad, "If you don't stop yellin' I tried to murder you, by Gosh, I'll murder you sure enough. By Gosh, I'll wring your neck the first time I catch you outside the plant gate."

"You hear?" demanded Pipenose. "Now you'll believe me. He's confessed. You heard him yourselves. I want him arrested. If you dopes won't call the cops, I'll do it myself."

He began to climb off the cot, his long nose sniffling like a leaky joint, and at that Gus got into a panic and went out the door like a boiler explosion.

"See?" said the doctor all excited. "What'd I tell you? You better catch him, quick. Before he murders somebody else."

So George ran after Gus like a second boiler explosion, showing over and over again (Oscar wrote disgustedly) that engineers hate to

PRACTICAL ENGINEER SECTION

look facts in the face. Everybody in the gas works should have known by that time what had happened to Pipenose. Do you?

Well, I didn't know what had happened, and being an engineer who finds reading easier than thinking, I read on.

Of course George couldn't find Gus, (Oscar continued) and in no time the whole works was in a panic from the stills to the waterfront, having heard somehow that Gus was running amok with a sword, a pistol, and a length of 2 in. pipe that rumor claimed he already had used on Pipenose. Never before did the day shift go home so fast. Not one of them even stopped for a bath.

The big Boss acting brave, held out long enough to put George on the carpet.

"Either you find Gus by morning," he bellowed as he always bellows trying to be impressive, "or you're fired. Do you realize you've let a potential murderer get loose in the gas works? Do you? Do you?"

George said he did, he did, being careful to answer each question, but in the end he was talking to himself. The Boss just bolted through the gate, instructing the gateman over his shoulder to warn the night shift.

George spent the night walking his feet off up to the ankles, and as he found nothing but rats, roaches, and three night men sleeping on their jobs, the situation was still unresolved.

And now, concluded the note, with the information you'll find on the next page, you must go to the big Boss, explain everything and save George's job.

But there was no next page. I looked all over the place and meanwhile the Boss came in and I could hear him bellowing for George in

'njuneers," I read, standing on my desk, "shud luk up somtims—"

the next office. The mystery ratrace had begun, and I started to sweat realizing Oscar had put me squarely in the middle of it.

Nothing but habit made me lean back in my chair and turn my eyes upward. I do that subconsciously when I'm trying to concentrate. And there on the gray ceiling, directly over my head were the final hen-tracks.

"njuneers," I read, standing on my desk, "shud luk up somtims nd c Gus on top uv 2 holdr also any coal min cnery can tel u gus u cant c or smel can make u fall on ur hed nd go crzy b4 ur ded oscr th gas wrks oul hoo cs al and nos al"

We have a sign now at the pipe tunnel which says: "Fresh air must be blown through this tunnel for 1 hour before it is entered."

As for Oscar, last night I tied a white mouse to the office rainspout and I guess he liked it first rate, because this morning the mouse was gone and I saw the word "thnx" scrawled on the pavement.

We Saved Money by Raising Steam Temperature

By SERGIO MARTINEZ, JR.

IN OUR PLANT we have three boilers with water-wall furnaces, designed to produce steam at 400 and at 700 F total steam temperature. These boilers have been operating for three years with a very good record, supplying steam to two 5000-kw turbine-generators. The turbine-generators supply all the electric power needed at the factory and also process steam needed by bleeding it from the 6th stage of the turbine.

At the time the plant was designed, the price of oil was much lower than it is now and electricity was produced at a fairly reasonable price. In the last three years, the price of oil has nearly doubled and the price of the kilowatt-hour has gone up about 80 per cent. Accordingly, we had to find some means to lower the cost of electricity for the factory.

After studying several schemes, we decided to increase the temperature of our steam from 700 F to 800 F by installing in the boilers new and larger superheaters and by changing the first wheels in the turbines. The new superheaters cost installed about $20,000 and the new wheels for the turbines about $6,000, making a total of about $26,000 total expense. Although this is quite a large expenditure, it will be paid for in a few years, after which a yearly saving is expected.

The figures are very simple. The generator efficiency is 0.966 per cent for both units and the mechanical efficiency is 0.99 per cent. The boilers will have the same efficiency as before, according to the boiler manufacturer, and the turbine efficiency with the new wheel will be nearly the same, according to the turbine manufacturer.

The water rate of the turbines at 5000 kw, non-extracting is, according to the manufacturer, 10.25 lb per kwhr.

We used the formula:

Lb steam per kwhr =

$3413 \div [h_1 - h_2 \times E_g \times E_t \times E_m]$

in which h_1 is enthalpy of steam at initial conditions; h_2 is enthalpy of steam at final conditions; E_g is generator efficiency; E_t is turbine efficiency; and E_m is mechanical overall efficiency.

For the original steam conditions, we know that $E_g = 0.966$ and $E_m = 0.99$; that the water rate is 10.25; that h_1 is 1362.7 at 400 psi 700 F; and h_2 can be calculated and is 915.0. Hence $E_t = 3413 \div (10.25 \times 447.7 \times 0.966 \times 0.99) = 0.778$; that is, turbine efficiency E_t = 77.8 per cent.

If we use now the same formula at 800 F, then

$E_g = 0.966$ $E_m = 0.99$ $E_t = 0.778$

h_1 is now 1416.4 at 400 psi 800 F

h_2 can be calculated and is 939.8

So the new water rate is

$3413 \div (476 \times 0.966 \times 0.99 \times 0.778) =$ 9.64 lb per kwhr

This represents a saving of 0.61 lb per kwhr or 6 per cent in the amount of steam consumed. Although this calculation is made for non-extracting operation, it can be made for extracting steam and the results will be very similar.

We can now calculate very easily the savings in fuel oil.

Our feedwater temperature is 325 which corresponds to enthalpy of 295 Btu per lb. Boiler efficiency is not considered in the following calculation, because, being the same in both cases, it will cancel out in the third step.

Boiler input at 700 F =

(1362.7 — 295) 10.25 = 10,950 Btu per kwhr

Boiler input at 800 F =

(1416.4 — 295) 9.64 = 10,800 Btu per kwhr

Fuel Saving = (10,950—10,800) ÷ 10,950 = 0.0137 or 1.37 per cent

Since our yearly bill for fuel oil is around $335,000, this means a yearly saving of $4,600. The return available for fixed charges will be $(4600 \div 26{,}000) \times 100 = 17.7$ per cent, which is very satisfactory here.

This improved performance represents about 62,000 gal less of oil we have to obtain yearly. This is also very important since the oil is still rationed here.

Although this operation is very

simple, the increase in the temperature should not be attempted before a careful study is made. The boiler manufacturer should, of course, be consulted about the new superheater and the turbine manufacturer should be consulted to see what changes are needed at the new temperature. The rating of the flanges and fittings in the main steam line should be checked with those of the ASA. Other points to check are the material of the bolts used in the flanges, the amount of insulation required, the flexibility of the piping and the reaction of the supports.

If the temperature or pressure of the supplied steam can not be raised, due to some limitation on materials, one should investigate the possibility of increasing the vacuum by one means or another. Very often a vacuum improvement of ½ in. results in a decrease of the water rate of about 0.5 per kwhr.

CALCULATOR FOR VOLUMES OF OIL AND OTHER PETROLEUM PRODUCTS

IN BOILER PLANT WORK, and a great deal of industrial plant work, engineers measure oil volumes at some existing temperature and correct the gallonages to net gallons at 60 F, which is the standard condition agreed upon by the oil industry. To make these conversions quickly and accurately, a new slide calculator has been developed and copyrighted, known as the Penn Drake Calculator, shown here. The principle employed makes the calculator usable for other petroleum products and for any liquid having a constant coefficent of expansion.

It is constructed of 4¼-in. by 9½-in. plastic jacket holding a heavy cardboard calibrated slide. Four different colored scales of gravity ranges are furnished on the slide by use of counter current tables. These are as follows: 1. High Gravity Gasoline & Naphtha, API Gravity 64.0 to 78.9. 2. Gasoline—Naphtha, API Gravity 51.0 to 63.9. 3. Kerosene—Fuel Oil, API Gravity 35.0 to 50.9. 4. Lubricating Oil—Wihte Oil, API Gravity 15.0 to 34.9.

Thus the complete API Gravity Range of the calculator runs from 15.0 to 78.9 (Specific Gravity 0.6725 to 0.9659) and includes the temperature range from 20 F to 120 F, which covers normal unloading and storage conditions for the various fluids. Complete instructions for use, with typical examples, are printed right on the calculator.

These calculators may be secured for $1.00 each from Pennsylvania Refining Co. (Attention: Robert W. Lackner) 2686 Lisbon Road, Cleveland 4, Ohio.

Editor's Note:—PLEASE DO NOT write to us nor send us any money for one of these calculators; instead write direct to Pennsylvania Refining Co. We do not have a supply of the calculators on hand. But so many readers have asked us how to convert oil gallonages to standard conditions that we are publishing this item for everybody's convenience. Volume conversion tables, were shown in POWER PLANT ENGINEERING, *January, 1947, page 102, and are given in a number of the standard engineering handbooks; but the calculator described above greatly simplifies and speeds up the figuring.*

* * *

Relatively dustless, rapidly-dissolving pellets of sodium pentachlorophenate are being offered by Monsanto Chemical Company, it was announced recently.

An industrial preservative and slime control agent, the chemical is sold under the trademark Santobrite. The pellets were developed by F. A. Linde, of the company's Organic Chemicals Division Development Department. They are said to have several advantages over the presently available forms of this material.

According to H. C. Koehler, special products sales manager, the seed-like kernels are free-flowing and go into solution faster under static conditions because they do not paste.

The granular form, Koehler said, was achieved by the addition of a non-adulterating agent. There is no decrease in assay over previous forms. Because of their higher apparent density, he said, the pellets may be more economically packed and shipped.

The pellets are suggested for many applications, such as in cooling water systems, paper mills, for sap-stain control and paint and glue preservation.

PRACTICAL ENGINEER SECTION

Slide-rule calculator for quickly converting volumes of oil and other petroleum products to standard conditions

"Psst, Bub—Wanna buy a couple tons of hot coal?"

BASIC POWER PLANT FIGURING — 4

A Review for Old-Timers — A Must for Young-Timers

How to Use the Mollier Chart

By WILLIAM H. ENGELMAN

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THE MOLLIER CHART gives a quick and simple solution of problems involving the properties of steam. As explained in Part 2, March issue, these properties are pressure in pounds per square inch (psi) or inches of mercury (in. Hg), Btu per pound, entropy, total temperature, degrees of superheat, and steam quality or per cent moisture. If two are known, the rest can be easily determined. The first five of these are all given in Keenan and Keyes Steam Tables. Plotting of these data in curve form permits curves of moisture to be shown; this is not possible in the steam tables, in which values of enthalpy for wet steam must be calculated by the method shown in Part 2.

IMPORTANT NOTE: The diagram shown here is for illustrative purposes and for practice in the method of use. For many practical problems, the values shown on it are accurate enough. But you will find, in a pocket in the back of *Thermodynamic Properties of Steam*, by Keenan and Keyes (the Steam Tables) a large 30 in. by 40 in. Mollier Chart. This is what you should use in the solution of practical steam problems.

But values on this large chart correspond to those given in the steam tables and it is a later and more accurate version, all values having been rechecked and recalculated in recent years by the authors aided by various authorities.

The chart is very useful in problems of steam expansion from a higher to a lower condition (and of compression from lower to higher) as they occur in steam engines and turbines, condensers, heaters, flow through valves and so on. It is useful in showing difference between expansion at constant entropy (isentropic expansion) and the actual expansion in practical engines and turbines that obviously cannot be 100 per cent efficient.

In steam turbine work it is extremely useful in showing the amount of moisture in the steam at exhaust conditions, a very practical factor having the most important effects in designing and operating steam turbines.

What the Mollier Chart Shows

The evenly-spaced horizontal lines represent the ENTHALPY (Btu per pound or total heat content) and are read at either right or left of the chart. The ENTROPY is shown by the evenly spaced vertical lines running from top to bottom, the values ranging from 1.0 to 2.0 and on the large chart up to 2.3.

Pressure lines run diagonally up from lower left to upper right, the entire height of the chart. They are indicated by the values at the lower right, starting with 0.2 of

Table I. Practical applications of the Mollier Chart. Corresponding points for each item lettered on chart on opposite page

A. Find Btu and entropy for dry saturated steam at standard atmospheric pressure of 14.7 psia. (No moisture or superheat).
Enthalpy is 1150.4 Btu per lb, entropy is 1.756.

B. Find Btu and entropy for steam at standard atmospheric pressure with 12 per cent moisture. (100% — 12% = 88% quality).
Enthalpy is 1035 Btu per lb and entropy is 1.584.

C. Find Total Temperature (T.T.), enthalpy, and entropy for steam at standard atmospheric pressure with 100 deg superheat.
T T is 212 + 100 = 312 F., enthalpy is 1198 Btu, entropy is 1.824.

D. Find T.T., enthalpy, and entropy for steam at 30 psia and 190 deg superheat.
T T is 440 F., enthalpy is 1255 Btu per lb, and entropy is 1.815.

E. Determine enthalpy and entropy for steam at 300 psia and 4% moisture.
Enthalpy is 1170 Btu per lb. and entropy is 1.474.

F. Determine T.T., deg superheat, and entropy for steam at 300 psia and containing 1278 Btu per lb.
T.T. is 540 F., superheat is 120 deg, and entropy is 1.590.

G. Steam at 1.5 in. Hg and 7 per cent moisture.
Enthalpy is 1028 Btu per lb., entropy is 1.870 and the temp. is 91.8 F

H. Steam at 29 in. Hg vacuum and 20 per cent moisture.
Enthalpy is 885 Btu per lb, entropy is 1.65, and temperature is 79.1 F.

I. Steam at 350 psia and entropy of 7.71.
Enthalpy is 1430 Btu per lb, T.T. is 820 F, and superheat is 390 F.

J. Find other items for 1 lb of steam at 580 F and entropy of 1.71.
Pressure is 140 psia, enthalpy is 1315 Btu and degree of superheat is 229 F.

Table III. Problems to be solved from Thermodynamic Charts by Ellenwood and Mackey. Check answers with Keenan and Keyes steam tables

Pressure, psia.	1000	400	240	50	6
Total temp.	840	880	560	380	280
Sat. steam temp.	545	444.6	397	281	170
Superheat, deg	295	435.4	163	99	110
Btu per lb	1413	1459	1298	1225	1185.5
Entropy	1.586	1.717	1.634	1.724	1.9044
Vol. cu ft per lb	0.717	1.940	2.420	9.800	73.20

Pressure, psia.	1700	625	270	106	23.5
Total temp.	870	570	592	410	260
Sat. steam temp.	613	490.5	407	332	237
Superheat, deg.	257	79.5	185	78	23
Btu per lb	1401	1267	1313	1232	1171
Vol. cu ft per lb	0.410	0.860	2.230	4.700	17.80

Psia Vacuum or in. Hg abs	500	100	29 in. Vac.	1.4" abs.	0.5" abs.
Qual. or Moist %	85% Q.	4% M.	16.6% M.	7.4% M.	91% Qual.
Sat. steam temp.	467	327.7	79.0	89.6	59
Btu per lb	1091	1151.5	922	1023.5	993.2
Entropy	1.523	1.505	1.6365	1.6515	1.735
Vol. cu ft per lb	0.790	4.250	544.0	440.0	1145

Note: See Index chart for steam on page 2, Ellenwood and Mackey.
Examples of the use of the charts on page 35, and 36.
See water charts on page 24 and 25.
Low quality steam chart on page 26.
Psychrometric charts on page 32, 33, and 34.

Table II. Problems to be solved by reference to Mollier Chart on opposite page. Locate values and check them with the steam tables

1. Dry sat steam at 160 psia expands at constant entropy to 3.0 psia. Find entropy, Btu., steam temperature, exhaust, quality and moisture.

Initial steam	Final Steam
1.5640 entropy	1.5640 entropy
1195 Btu per lb	930 Btu per lb
364 F.	142 F.
100% quality	81% quality
0% moisture	19% moisture

2. Steam at 240 psia and 97% quality expands at constant entropy to 10 psia. Find entropy, Btu., temperature, quality and moisture.

Initial steam	Final steam
1.5000 entropy	1.5000 entropy
1175 Btu per lb	955 Btu per lb
398 F.	193 F.
97.0% quality	81.0% quality
3.0% moisture	19.0% moisture

3. Steam at 350 psia and 500 F. expands through a pressure reducing valve to 10 psia. What are the conditions of the initial and final steam?

Initial steam	Final steam
1.5470 entropy	1.9300 entropy
1251 Btu per lb	1251 Btu per lb
500 F total temp.	422 F total temp.
68 deg superheat	230 deg superheat

Show solutions of these three problems with ink lines on chart.

4. Turbine-generator is supplied with steam at 400 psia and 740 F tot. temp. The vacuum in the condenser is 29.5 in. Hg. Find the following:
a. Adiabatic heat drop (constant entropy).
b. Practical heat drop with 70% efficiency.
c. Moisture in steam for condition under a and b.
d. Foot-pounds of work per lb of steam
e. Pounds of steam required per kw-hr

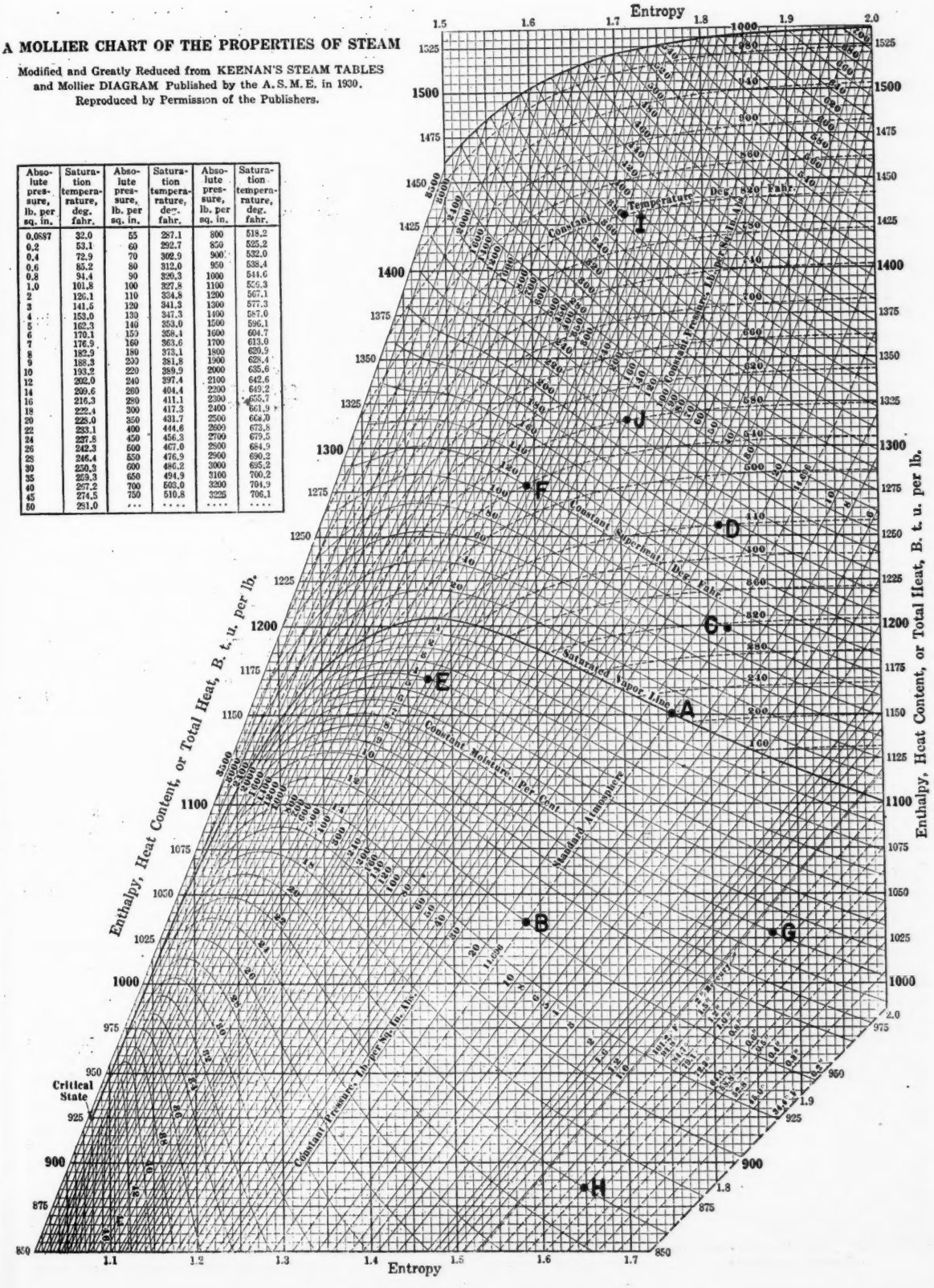
Initial steam	Final steam (theor.)
400 psia—740 F	29.5 in. vacuum
1385 Btu per lb	860 Btu per lb
1.658 entropy	1.658 entropy
295 deg superheat	21.4% moisture
	525 Btu drop
	Final steam (70% eff.)
	29.5 in. vacuum
	1017 Btu per lb
	1.965 entropy
	6.6% moisture
	368 Btu. drop

Heat absorbed by turbine is 368 Btu per lb of steam.
One pound of steam contains 368 x 7778 or 286,300 foot-pounds.
Since there are 2,656,000 Btu in one kw-hr
2,656,000 ÷ 286,300 is 9.28 lb of steam per kw-hr. (steam rate).

A MOLLIER CHART OF THE PROPERTIES OF STEAM

Modified and Greatly Reduced from KEENAN'S STEAM TABLES and Mollier DIAGRAM Published by the A. S. M. E. in 1930. Reproduced by Permission of the Publishers.

Absolute pressure, lb. per sq. in.	Saturation temperature, deg. fahr.	Absolute pressure, lb. per sq. in.	Saturation temperature, deg. fahr.	Absolute pressure, lb. per sq. in.	Saturation temperature, deg. fahr.
0.0887	32.0	55	287.1	800	518.2
0.2	53.1	60	292.7	850	525.2
0.4	72.9	70	302.9	900	532.0
0.6	85.2	80	312.0	950	538.4
0.8	94.4	90	320.3	1000	544.6
1.0	101.8	100	327.8	1100	556.3
2	126.1	110	334.8	1200	567.1
3	141.6	120	341.3	1300	577.3
4	153.0	130	347.3	1400	587.0
5	162.3	140	353.0	1500	596.1
6	170.1	150	358.4	1600	604.7
7	176.9	160	363.6	1700	613.0
8	182.9	180	373.1	1800	620.9
9	188.3	200	381.8	1900	628.4
10	193.2	220	389.9	2000	635.6
12	202.0	240	397.4	2100	642.6
14	209.6	260	404.4	2200	649.2
16	216.3	280	411.1	2300	655.7
18	222.4	300	417.3	2400	661.9
20	228.0	350	431.7	2500	668.0
22	233.1	400	444.6	2600	673.8
24	237.8	450	456.3	2700	679.5
26	242.3	500	467.0	2800	684.9
28	246.4	550	476.9	2900	690.2
30	250.3	600	486.2	3000	695.2
35	259.3	650	494.9	3100	700.2
40	267.2	700	503.0	3200	704.9
45	274.5	750	510.8	3225	706.1
50	281.0	...	....	....	....



mercury absolute and going up to 2.0 in., then by various steps to 3,500 psi absolute and marked CONSTANT PRESSURE, Lb per Sq In. Abs.

Moisture or Quality Region

On the large chart, lines are shown for *vacuum* from the ½ in. to 3 in. Hg for convenience in turbine and condenser calculations.

The chart is divided in two parts, separated by the Saturated Vapor Line, which forms the border line between the SUPERHEAT REGION, also known as TOTAL TEMPERATURE REGION, and the WET or MOIST REGION, known also by the term STEAM QUALITY REGION or per cent MOISTURE.

Superheated Steam Values

The upper part gives the ENTHALPY or Btu content per pound of SUPERHEAT steam, read at the right or left edges of the chart. The curved lines marked CONSTANT SUPERHEAT, running almost parallel with the saturated vapor line, represent degrees superheat, showing the temperature above that corresponding to saturated steam. The curved lines starting mostly at the left and rising gradually to the right represent TOTAL TEMPERATURE (TT), and give the combined temperature of saturated and superheated steam.

The moisture content in per cent, also sometimes expressed as quality of steam (100—% moisture) is read from the lower part of chart below the saturated vapor line and marked CONSTANT MOISTURE, PER CENT.

It should be noted that the temperature of steam at any moisture is the same as that of dry saturated steam at the SATURATED VAPOR LINE. These values may be read from the table accompanying the chart.

Special Tables for Turbine Calculations

In many turbine and other fluid calculations you have to make, you will frequently need relations between steam volume, enthalpy, pressure and temperature. These have been charted on special charts in *Thermodynamic Charts* by Ellinwood and Mackey, 2nd Edition 1944 (John Wiley & Sons) Price $2.75. These give charts for steam, water, low-quality steam, ammonia and Freon—12.

You should examine these charts carefully and learn how to use them to save time, laborious calculations and reduce chances for error. Table III shows some typical problems solved on these charts.

NEXT TIME: How to calculate steam flashing problems

LETTERS TO THE EDITORS

(Continued from page 53)

two gallons of sea water. The sea water pumped to the evaporators in each of the four plants is then 50,000,000 gpd or about 35,000 gpm. The blow-down water must be returned to the ocean and, since the evaporators are under low pressure, or even a vacuum, this water must be pumped. At a velocity of 6 fps, the size of main to the evaporators would be 48 in., and the main from the evaporators about 36 in. The four plants to pump 200,000,000 gpd to the evaporators and 100,000,000 gpd from the evaporators cannot be had at "small cost."

We have now come to the evaporators—the major item. A well designed evaporator will produce about 130 gal of distillate per sq ft per day. If the evaporator could be operated without shutdown for cleaning there would be required a total of about 700,000 sq ft of surface. But since it must be "out" occasionally for the removal of scale, there must be additional evaporators to maintain the desired output; say a total of about 1,000,000 sq ft.

Besides the usual accessories to the evaporators there would be required condensers for the final-effect vapor and, in a plant designed with due regard for economy, there would also be heat-exchangers to conserve heat and at the same time cool the distillate before pumping it into the mains. The cost of the evaporators, their accessories, auxiliaries, buildings, etc., would depend on whether the plant were made up of large units or a large number of comparatively small units. Anyway, the cost of the complete plant probably would not be far from $10 per sq ft of evaporator surface; so there would be an investment of about $10,000,000 for the evaporator equipment alone. Altogether, the cost of the project; evaporators, pumps, reservoirs, buildings, water mains, etc., would amount to many millions of dollars!

The number of effects decided upon in an evaporator problem is determined by the available temperature of steam as well as the first cost and operating costs of the evaporators. A temperature drop of 40 to 50 deg in each effect would be necessary to keep the number of units, and consequently the investment, from reaching fantastic proportions. It seems, therefore, that a quadruple-effect unit would require a temperature difference of about 200. And since the temperature in the final effect must be kept above 160 to guard against pathogenic bacteria, it seems that the steam must reach the first effect at a temperature of 360 deg with its corresponding pressure of 148 psi—hardly what would be called "exhaust" steam.

Whatever the source of the steam beginning operations in the first effect, it must give up its heat of evaporation and a portion of its sensible heat; a total of roughly 1,000 Btu per lb. A quadruple-effect evaporator will produce about 3 lb of distillate per pound of primary steam; so to produce 100,000,000 gallons, or 833,000,000 lb of distillate per day, there would be required 278,000,000 lb per day, or 11,600,000 lb of steam per hour. The combined capacities of the four big steam plants referred to in the foregoing is but a fraction of what would be necessary!

The recent statement that an acre-foot of fresh water can be produced at a cost of $17.50 gives evidence of ignorance or extremely careless computation. An acre-foot of water contains 43,560 x 7.48=325,800 gal. Then for one cent there would be produced 186 gal or 1550 lb. of distillate—a preposterous error! If the primary steam were produced in an oil-fired steam-boiler, and the only item of cost were the fuel, it would have to be obtained for about 9 cents a barrel.

That sea water contains "valuable minerals" is true. In fact, the extraction of magnesium from sea water is a well-established industry. And there is enough gold in the oceans to make multi-millionaires of every man, woman and child on earth. But until means of profitably extracting a grain of gold from a ton of sea water is developed, the gold will remain right where it is—in the sea water.

Opinions, expressed and implied, seem to take the engineering profession to task for its failure to economically render sea water fit for domestic use. Which is due, of course, to ignorance of the difficulties involved. If sea water is ever rendered fit for domestic purposes economically, it will not be by means of heat, but by means of chemical or electrical precipitation.

C. O. SANDSTROM
Civil & Mechanical Engineer
Los Angeles 4, Calif.

DOUBTFUL WATER LEVEL

MOST IMPORTANT, what is the RIGHT thing to do? Is there any one correct procedure to follow in all cases and are all other procedures wrong?

This question, originally raised several months ago, came up in connection with statements in the 8th Edition of *Power Plant Engineering* Questions and Answers Book.

It has been extensively discussed in these columns ever since Glenn Browning, (July 1947 issue) said the thing to do was to stop all firing but leave steam output and feed-

water input unaltered. Marvin Persinger, however (March 1948 issue) could not agree with this, saying he believed, after stopping fuel supply, it is best to close main steam and feed stops and open superheater vent, all for reasons he gave in detail.

This question was discussed back and forth for some time between Messrs. Browning and Persinger until at last D. E. Carroll entered the discussion to disagree in part with both of them. Mr. Carroll says feedwater supply should be increased to bring level back to normal and kept there until the boiler is cooled down.

Now this whole discussion, which has brought out much fundamental information on boiler operation, is much more important than it seems on the surface. Why? Well, hear Mr. Persinger again.

Why We Need Some Agreement on Low Water Level Procedure

ON THIS all important subject, we now have three controversial opinions; these of Mr. Browning, Mr. Carroll, and the writer. Since this subject is of such extreme importance, it would seem that what we now need is the opinion of a real authority. A suggestion as to the source of this authority would be a man connected with one of the leading boiler manufacturers, or a man long associated with a utility. The subject is not one to which a number of theories can be adapted; one procedure is correct, and the others are wrong. I am quite sure that we have all learned something from the comments presented; but, on the other hand, I believe that a definite conclusion should be reached before the subject is permitted to drop from these pages. It is quite evident that men throughout the profession are not in agreement.

Low water is the greatest single cause of boiler casualty and, to most engineers, a most dreaded emergency. If the procedure the writer submitted is wrong, and a boiler can be handled with a greater degree of safety by another method, then I shall be deeply indebted to the man offering a more logical solution.

There isn't a great deal that I can add to my original comment, other than to further emphasize that the operator's greatest concern should be protection of the boiler drum. This represents a major item of pressure part investment. Tubes, if damaged, can be replaced with comparatively little expense; a damaged drum, on the other hand, requires a capital replacement. We should bear in mind that with almost any water-cooled furnace boiler, once the fires are out, further temperature rise is unlikely in any pressure part if feedwater and steam stops are secured and the superheater adequately vented. In other words, if low water hasn't caused failure before this procedure is followed, then failure isn't going to occur.

A word of caution concerning feed flow with units having economizers. Flow must never be interrupted until heat input has definitely been interrupted. A failure occurred a few years ago in a 450-psi, 750-F, plant, in which a friend was employed as watch engineer. The boilers were equipped with both economizers and air heaters. The engineer had finished cooling a water sample for analysis, and after checking boilers and turbine departed to a laboratory adjacent to the turbine room to check the water condition. In a minute or two the fireman's frantic call brought him back to the boiler room to find water entirely gone from the glass on one unit. Before he could interrupt oil supply to the burners he was losing economizer tubes.

Unfortunately, the exact cause of feed flow interruption was never determined, because at the time the engineer had his hands full. When repairs were completed and the boiler returned to service, all equipment functioned perfectly. Perhaps the feedwater regulator was at fault, since the other boiler held a normal level. Regardless of the cause, if the fireman had been alert, the accident could have been avoided. But excellent equipment evidently made his job routine to the point where he relaxed.

While on the subject it might be well to point out that in the past few years two very interesting articles have appeared in POWER GENERATION in which the ability of boiler drums to absorb thermal shock and the effect of abnormal skin temperature on drum steel have been discussed. The first article entitled Preparing a Steam Generator for Service, by the late John C. Gore, appeared in the November, 1946, issue; The second entitled Safe Boiler Operation by Max H. Kuhner, Chief Mechanical Engineer, Riley Stoker Corp., also appeared in the same issue.

Baltimore, Md. MARVIN M. PERSINGER

Editor's Note—Agreeing with Mr. Persinger that we ought to come to some conclusion on this question, here's what we plan. We shall send tear sheets of this discussion to a number of leading engineers asking for their views on it. Then, identifying them only as Engineer A, utility, Engineer B, industrial plant, and so on, we shall publish them in tabular or perhaps symposium form, to see if any conclusions can be drawn from them.

FIFTY YEARS OLD—STILL GOING STRONG

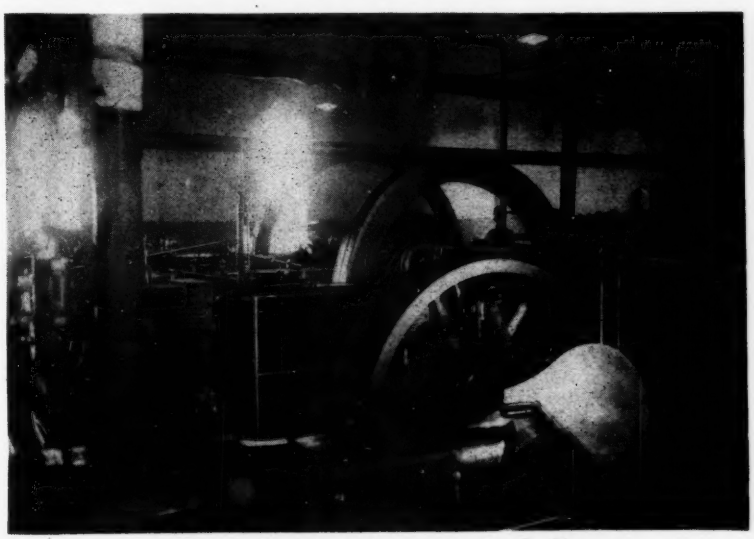
I READ WITH interest the article in the December 1948 issue on the retirement of the old Corliss engine at the National Cash Register Co.

I am sending you a photograph of the engine room of the Newton (Kansas) Ice Co. The machine in the center of the picture was built in 1898, making it 50 years old. It was moved from its original location to this plant in 1906. It was built by the Ball Ice Machine Co. of St. Louis. The ammonia cylinder is 10 by 32; the steam side is a simple Corliss, 14 by 32.

This machine is still in operation about 70 per cent of the time. The plant uses natural gas as fuel.

Newton, Kansas

LELAND KENAGY
Chief Engineer,
The Newton Ice Co.



The engine in the center has been in operation for 50 years

Questions and Answers

Question No. 439

ANSWER YES OR NO!— ARE PISTON RODS EVER BOWED?

IN OUR POWER PLANT we have a steam-driven reciprocating air compressor that has been dismantled for complete overhaul. This unit is rated 5000 cfm and is driven by a condensing, cross-compound Corliss engine of about 900 hp. The operating conditions of this engine are:

Throttle steam pressure	165 psig
Steam temperature	465 F
Vacuum	28"
Rpm	100
Air pressure	100 psig
HP steam cylinder	22" diameter
LP steam cylinder	48" "
LP air cylinder	41" "
HP air cylinder	25½" "
Stroke	36"

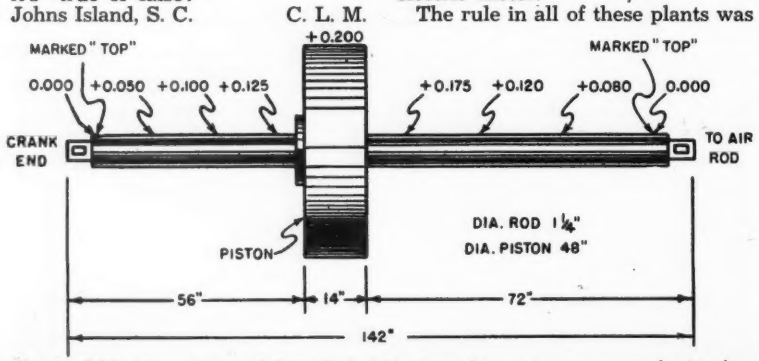
Both piston rods are supported by guides between the steam and air cylinders. The LP air piston rod has a tail rod, but the HP air piston rod does not.

The machine shop that is doing this overhaul reports that the HP steam rod, the LP steam rod and the LP air rod are bent; they report the HP air rod straight. Enclosed is a rough sketch of the LP steam rod as received from the machine shop. These rods are marked TOP on the ends.

Is it a practice of engine builders to manufacture rods of this type with bow to compensate for the weight of the piston? Years ago I worked in a plant with a similar engine of about the same size and duty. The Chief Engineer there said that the piston rods were built that way and I accepted his statement without question.

Now I am in the position of wishing to prove that rods have been manufactured with bow in this way; but I cannot find any such proof. Can Q & A readers tell me whether it's "true or false?"

Johns Island, S. C. C. L. M.



Sketch of LP steam piston rod from C. L. M.'s steam-driven air compressor showing bow as measured by machinists overhauling it. Was it bowed purposely to compensate for piston weight?

Question No. 440

HOW CAN HE COMPARE SIMPLEX AND DUPLEX PUMP EFFICIENCIES?

WHAT METHODS should I use to compare the efficiencies of a simplex pump and a duplex pump in order to determine which would be the most efficient to use in a given case?

That is, what data would I have to obtain—or assume—on capacity, head, strokes per minute and so on to make this analysis? Could curves be plotted like those for centrifugal pumps and if so, what would they look like?

Long Island, N. Y. J. B.

Editor's Note:—This question does not specify whether he means direct-acting steam-driven pumps, crank-and-flywheel steam-driven pumps or power-driven pumps. It seems to involve the whole subject of reciprocating pumps and pump duty, a measure of their economy. Will Q & A readers comment on the subject briefly for this engineer?

Answer No. 436

HOW MEASURE COMPRESSED AIR SYSTEM LEAKAGE?

Time Compressors and Test Lines

BEFORE World War I, when I was operating compressor plants on construction jobs as my regular occupation, I never had any difficulty finding out when there were serious air leaks on the system, and I didn't have any instruments either.

These compressor plants were all motor driven. The smallest plant had two compressors, one driven by a 200-hp and one by a 75-hp motor. The largest plant had three compressors, each driven by a 200-hp electric motor.

The rule in all of these plants was to start up the compressors 20 min before the morning and afternoon work periods began. All compressors operated at constant speed, and were equipped with unloaders that stopped them from pumping when the pressure was up, and cut them back in again as soon as the pressure dropped 5 lb. With everything tight on the system, the unloaders would cut out the compressors after a certain interval of pumping.

If the interval required to bring the system up to full pressure was too long, I notified the master mechanic, who immediately sent some one out to check the system over. On two occasions, valves were found wide open. On another, pipe men had taken out a branch line and neglected to plug the tee.

During work hours, I knew how many compressors were required for a certain number of air-consuming machines. If more compressor capacity was required than I thought necessary, a similar check was made, which usually disclosed some machines in need of re-packing, or some leaking or partially open valves.

Another check was available at quitting time by noting the interval of the unloading period, or how long it took for the pressure to drop a certain number of pounds after all the machines using air had stopped operating.

Keeping the system tight was a matter of the compressor operator knowing his business and keeping a close check on his plant throughout his watch. All hands were ready to jump on the compressor operator if the pressure was too low. Therefore, the compressor operator aimed to get there first, if he detected air leaks on the system outside of the compressor plant.

The business of the company was moving rock, and compressed air at full pressure was required to do this. Also, power to operate the compressors cost money. The superintendent and the master mechanic could be depended on to start things moving quickly if air was wasted unnecessarily.

My suggestions to F.N.B. are that when his system has been overhauled and he knows that all parts of it are in first class condition, on a day when his plant is out of service he can pump the system up to full pressure and note the time taken. He might do this in intervals: first to 50 lb, then to 75, then to 90, and last to 100 or 110, which is top pressure for most systems. Then, shut off the compressor and note the time it takes to drop back, at intervals, to, maybe, 75 lb. After several trial runs, he should have an average of the time it takes to pump up his system, and the rate at which the pressure will drop. With these tests recorded, later on he can run

brief tests at intervals, checking the pumping up time and decrease in pressure intervals against the original tests.

If F.N.B. has a large system, as in a shipyard, he should run tests with miscellaneous arrangements of branch air lines to various parts of the plant. Also, tests should be run with various numbers and types of air consuming machines in service. From this, a schedule should be worked out of the compressor capacity required to certain numbers and arrangements of air consuming machines.

Then, if excessive air compressor capacity is required, it is time to check the system over to determine when the excess compressed air is escaping.

Los Angeles, Calif. HOWARD T. LIVINGSTON

Solution Very Difficult; Many Variables

OBVIOUSLY the first step is to determine the theoretical plant load for a certain unit of time for any plant in question. This is a difficult task to perform. Pneumatic equipment manufacturers will and do give the cfm rating of their machines in terms of free air.

But air-consuming machines do not operate continually without stopping. Take, for example, an automatic press or stamper; this machine will operate at a given rate per unit of time so long as the work is coming off the line satisfactorily. But when adjustments have to be made, work changed, minor repairs made or work shortage, the machine is not operating. Yet the theoretical plant load has to assume that this machine does or will work continually in order to determine maximum load or air demand. Consequently, there can be leaks on machines operating while other machines are shut down; and the actual load will still be below the theoretical load.

Further, air used for blowing or cleaning during working periods, unless it is on a separate line and metered, is impossible to determine or even estimate. Further still, around a large plant, there is a large amount of air wasted. Employees are careless about shutting air valves off tight or will leave a hose blowing when not needed. Hose or air tools leaking may not be reported or repaired. This source of leakage is impossible to determine.

But, assuming we have arrived at a fairly accurate theoretical air load, the next obvious thing is to install a recording type air flow meter in the main line. The theoretical air load has to be changed from free air to air at the operating pressure or the actual load (meter reading) changed to free air. Then the difference between the actual load and the theoretical load will indicate the plant leakage. This of course does not take into consideration any leakage between the compressors and the meter.

In small installations, such as a small laundry, for example, the expense of meters and their maintenance would not be practical. Cost of installation will more than offset the savings by the information they will give; and it may be easy to find the leaks when the plant is shut down. If leaks were found previously, they would have to wait for the shut-down period anyway.

In large installations, where air is supplied by the main engine room; where many machines are located on several floors of several buildings; where the number of machines and operations are never constant; where the plant is operating 24 hr a day but departments are all working at different times, trying to balance the theoretical load against the actual load for any unit of time would be impossible. The meter would be useless because there would be no way of knowing whether machines were shut down or operating.

Assuming, however, we did arrive at a theoretical air load for a unit of time, and by means of the meter knew there were leaks. Our information would be useless because we would still have to cover the entire plant to find the leaks. In all large installations where there are many people using air for all types of work and handling many types of pneumatic machines, there are always hundreds of small leaks. Many of these are in out of the way places and, due to noise of the machinery cannot be heard. Leaks around overhead lines on valves, joints, and gaskets require a special detail to find them.

The only practical solution to the problem, then, is to organize a systematic check on all equipment during shut-down periods. All items accessible for inspection during working hours, such as air hose and air tools, should be checked periodically or when signs of leakage occur. Display cards advising the economical use of air will also help to keep the air load down.

Baltimore, Md. CHARLES W. PARKS

PRACTICAL ENGINEER SECTION

Most States have boiler rules which require the safety valve to be attached to the boiler as close as possible to the safety valve nozzle.

Apparently the pipe nipple between the nozzle and the valve was serving no useful purpose, hence he removed it. It is my opinion that the real cause of difference between the point at which the valve popped and the gage reading, was found and remedied by the field engineer without divulging its nature. This might easily have occurred unless some one was with him all the time.

Although the reason advanced by the field engineer left L.T. still wondering, the latter was forced to accept it at face value.

This question brings to mind a tragic occurrence—in the light of subsequent events it could hardly be called an accident—which occurred in the writers home State some forty years ago.

A steam-powered plant for harvesting natural ice was being made ready for the first day's operation. The boiler had been inspected and certified for 85 psi working pressure. Steam was being raised and when the pressure gage read 15 psi, the safety valve popped. The steam gage was suspected of being at fault, so it was removed, taken to the local plumbing shop, tested and found to be correct.

It was replaced on the boiler and steam again raised. When it popped at 15 psi a second time, the engineer started operating on the safety valve, but he never did get the gage to read at the certified pressure, although it came up a few pounds every time he twisted the safety valve adjusting nut a few turns more.

A sudden earth-shaking blast snuffed out his life, that of his son, and fourteen laborers who were warming themselves in front of the boiler.

The hurtling shell of the boiler mowed a swath through a grove of trees for several hundred feet. Miraculously, and fortunately as well, the safety valve was not seriously damaged. Recovered and tested, it popped at 365 psi.; over four times the pressure it was certified for.

The gage and its connecting pipe were also recovered and examined.

The gage tested correctly, but the source of the trouble was found to be an obstructed gage pipe which allowed the gage to read only a fraction of the true boiler pressure.

I lived but a few miles from the scene of the tragedy at the time, and being engaged in the interesting process of becoming an engineer, it made an impression on me which I have never outgrown.

Plymouth, Mass. C. BROOKS HUDSON

Answer No. 435

WHY DID NIPPLE CAUSE SAFETY VALVE TO BLOW INCORRECTLY?

Maybe it Was Something Else, says Hudson; Cites Case of Obstructed Gage Connection

REGARDING the peculiar action of a new safety valve which was set for 140 lb, yet blew at 75 lb when first put under steam pressure (assuming all pressure-gages tested as stated), the reason advanced by the field engineer for its peculiar action reminds me of a stock expression used by a former supervisor in similar circumstances — just plain "hokus-pokus."

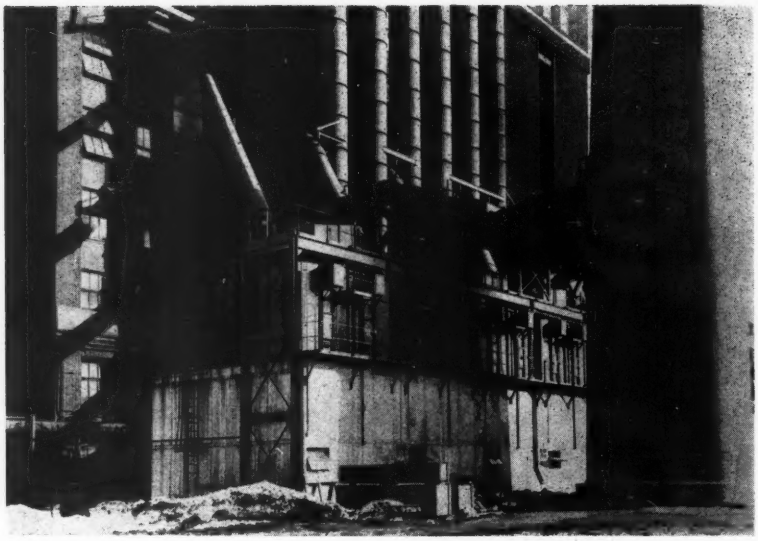


Fig. 1. The bag filter installation at East River Station. Visible are two of the ducts connecting the pulverizing mills to bag filters inside the metal housing

Automatic Fire Protection for Pulverized Coal Filters

By W. E. MORGAN, Manager, Industrial Dept. Walter Kidde & Co., Inc.

To SAFEGUARD six new bag filter units for pulverized coal, completed in 1943 at their large East River steam-electric generating station in New York City, the Consolidated Edison Co. of New York, Inc., had an automatic carbon dioxide fire extinguishing system especially designed and built into the structure housing the filter installation.

Operating on a large-scale vacuum cleaner principle, each bag filter unit is connected directly to one of six coal pulverizing mills located in the adjacent mill house. Coal particles, some of which would otherwise escape into the atmosphere, are drawn from the mills through ducts to the filters and trapped in cloth bags. The bags are shaken periodically and the accumulated coal particles are deposited in hoppers, from which they are removed by activation and piped to coal bins to be fed as fuel to steam generating boilers.

Such handling and temporary storage of fine coal particles, transported through ducts as a dust-laden atmosphere, present a serious fire hazard. Ignition from an electrical spark or other source might easily start a conflagration that would be practically impossible to reach or combat with first aid fire fighting equipment. The only dependable solution is a built-in automatic detecting and extinguishing system that will create an inert atmosphere in case of fire and smother the incipient blaze quickly.

The Kidde carbon dioxide extinguishing system protecting the filter bag installation comprises two banks of 21 cylinders, each containing 50 lb of liquid carbon dioxide. Manifolded together for discharge as one main and one reserve bank, the cylinders are located in the activator underneath the filter housing.

Both banks of carbon dioxide cylinders are connected by rigid piping to a series of 60 discharge nozzles mounted at strategic points inside the ducts leading from the pulverizing mills to the bag filters, in the bag filter compartments, and in the hoppers into which the bags are periodically emptied.

If the temperature in any of the bag filter compartments, ducts or hoppers reaches 275 F, enclosed thermostatic controls, also mounted inside the filter bag housing, actuate a release mechanism that automatically opens the discharge valves of the main 21-cylinder manifold, releasing the carbon dioxide into the distribution piping.

Directional valves in the piping network, located near the cylinder banks, direct the carbon dioxide to the proper protected space. Simultaneously, relays shut down the pulverizing mill connected to the burning filter bag unit and ring an alarm, and pressure trips in the piping close duct dampers.

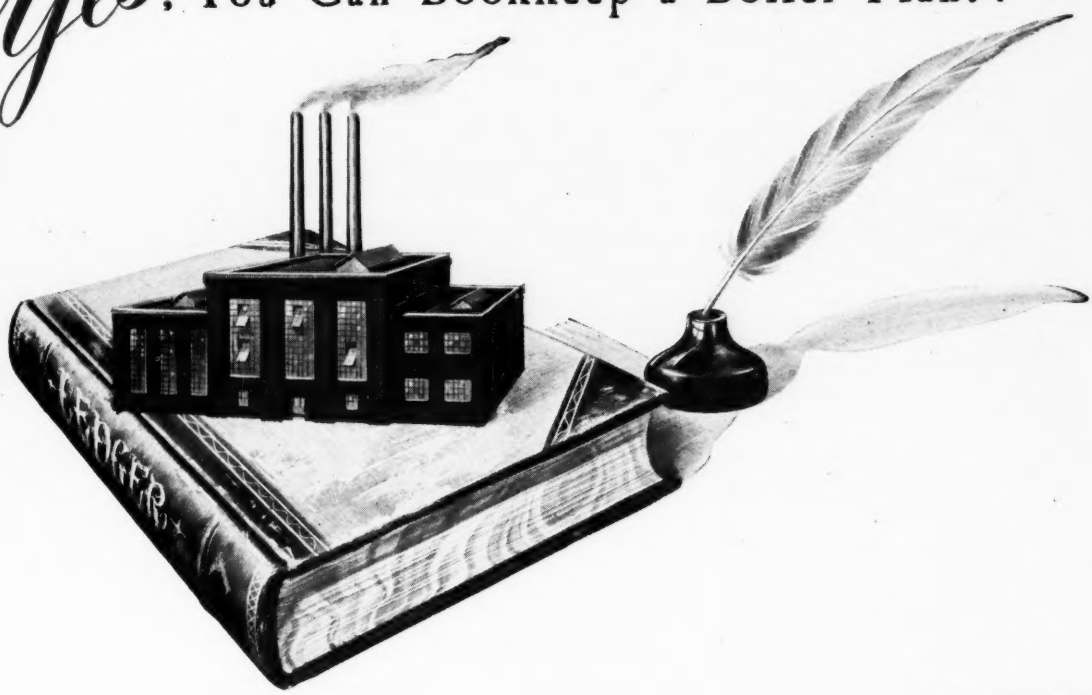
Stored under 850 psi pressure, the carbon dioxide possesses its own propellant energy. In a matter of seconds it reaches the discharge nozzles and becomes a gas.

As soon as the main bank of cylinders discharges, the reserve bank becomes the main bank, through manual tie-in controls. As soon as the empty cylinders in the main bank have been replaced by full ones, the reserve bank reverts to its original status. This added safety measure assures continuous fire protection for the six filter bag units.

Fig. 2. Main bank of 21 cylinders, each containing 50 lb of CO_2 and a similar reserve bank are located in the activator compartment underneath the bag filter housing of one of the six bag filter units

Fig. 3. Directional valve panel controlling flow of CO_2 from main and reserve cylinder banks to each of the six bag units is located in some activator compartment as main supply tanks

Yes, You Can Bookkeep a Boiler Plant!



The economic advantage of a correct and complete water conditioning service in your boiler plant can be readily figured. It is a sum of savings effected through elimination of the many unnecessary shut-downs directly traceable to an inefficient water treatment.

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BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

How to Prevent Ion Leakage in Exchange Treatment of Feedwater

Leakage means sodium ions in effluent during hydrogen cycle, calcium ions during sodium cycle . . . Keep regenerant level low and thus keep regenerant cost down . . . Little leakage with high alkalinity water . . . Use up-flow regeneration to get economy of low-level leakage . . . Curves show balance between capacity and regeneration level, to find most economical lb salt per cu ft of resin . . . Curve shows effluent quality for high cation content influent

By JOSEPH THOMPSON and FRANCIS X. McGARVEY
The Resinous Products Div., Rohm & Haas Co.

OF GREAT IMPORTANCE to power plant engineers operating ion exchange units for the treatment of boiler feedwater is an understanding of the phenomenom of ion leakage. Such understanding permits economy in the use of regenerants and provides increased efficiency in the performance of ion exchange installations.

Leakage is the presence of sodium ions in the effluent during hydrogen-cycle exchange, or calcium ions in the effluent during sodium-cycle operation. This is how it occurs:

In the hydrogen cycle, the "bases" or cations can be visualized as being adsorbed* on the resin bed in bands according to their decreasing affinity: iron, aluminum, calcium, magnesium, potassium, hydrogen. When a water high in sodium concentration has been treated and insufficient regenerant has been used, the lower portion of the bed remains in the sodium form, even though the upper portion has been completely converted to the hydrogen form. Then, when service flow is resumed, cations are exchanged for hydrogen in the upper portion of the bed. As an acid water thus formed passes through the lower portion of the bed, the loosely-held sodium ions in the lower portion of the bed are displaced by the hydrogen ions and appear in the effluent.

* See How Ion Exchange Resins Work; POWER GENERATION, Feb., 1949, page 94.

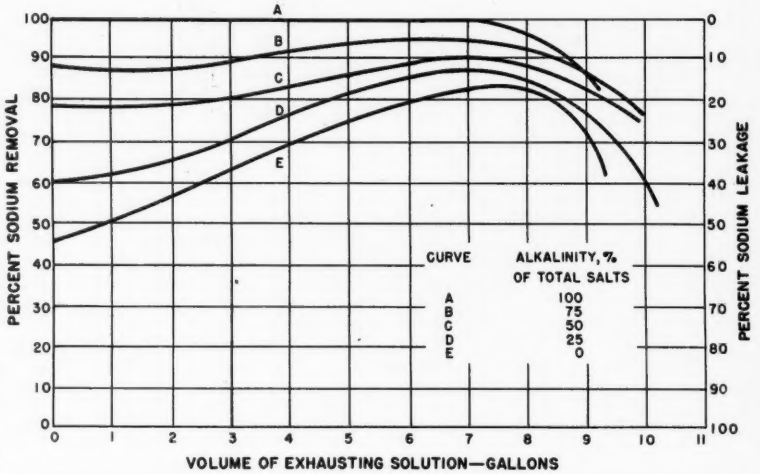


Fig. 2. Sodium leakage as related to alkalinity. (Regeneration level—1.5 lb 66 deg Be H_2SO_4 per cu ft)

Excessive leakage is undesirable, but economy dictates the use of low regenerant levels since the cost of regenerants is the significant operating expense of ion exchange. In order to determine efficient regeneration levels, a series of studies were run on Amberlite IR-100 in which the water contained only sodium chloride. Figure 1 demonstrates the effect of varying the acid regeneration level from 1.0 to 5.0 lb 66 deg Baume sulfuric acid per cubic foot of Amberlite IR-100. At low regeneration levels, excessive leakage of sodium ions occurs early in the exhaustion cycle because of incomplete regeneration of the lower portion of the exchanger bed. The leakage decreases during the run because the sodium in the lower portion of the resin bed is progressively exhausted.

Amount of sodium increases directly as the concentration of sodium in the influent increases, but the percentage remains constant. If the regeneration level of the resin is constant, the curves in Fig. 1 would be about the same whether the raw water contained sodium salts in concentrations of 100 or 1000 ppm.

The power plant engineer can save on regenerant costs by using only enough to obtain the desired aver-

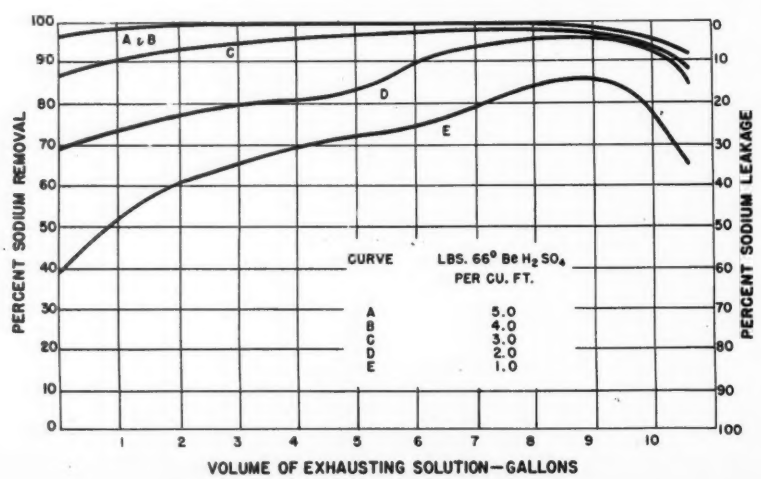
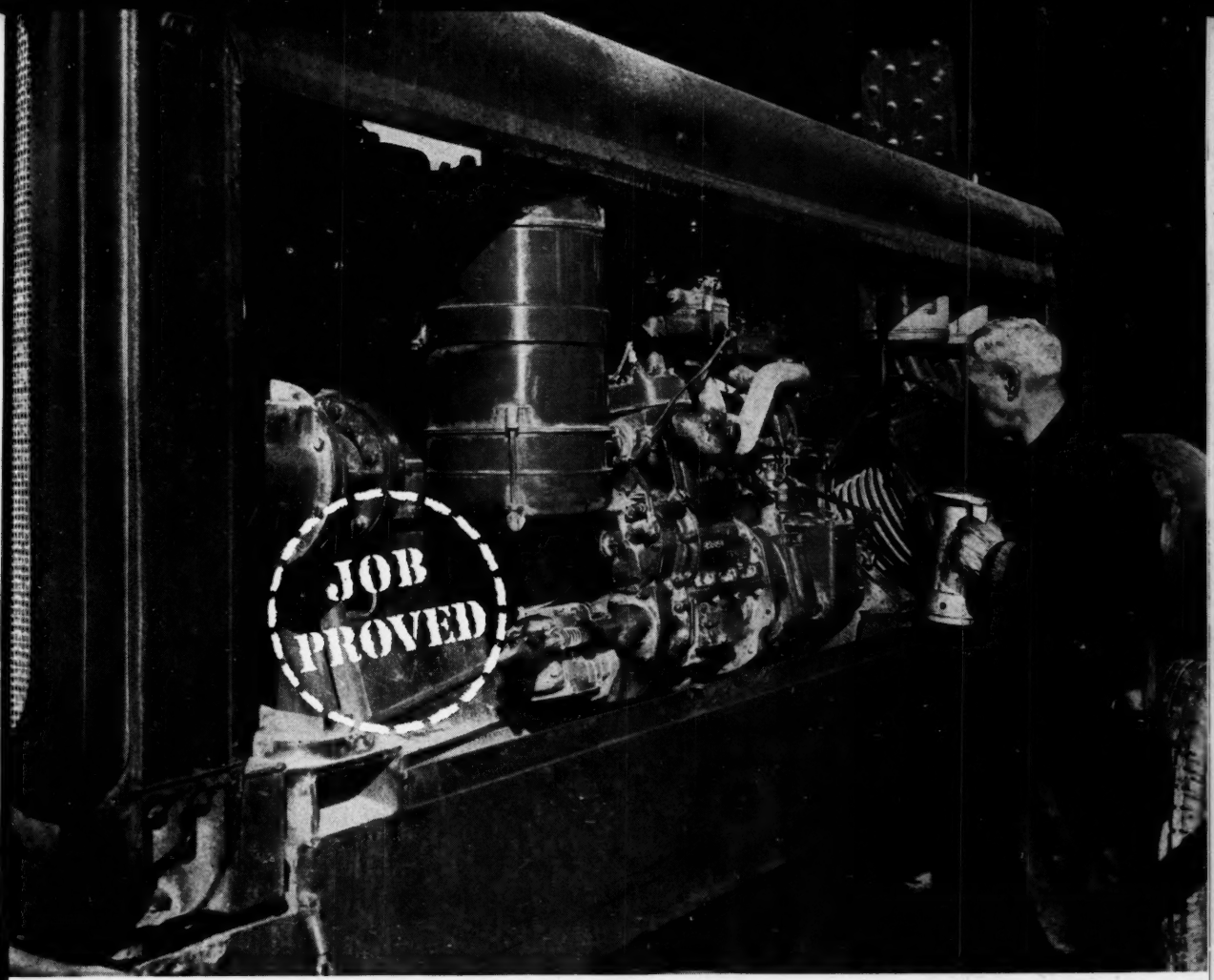


Fig. 1. Sodium leakage as related to regeneration level



DIESEL MAINTENANCE CUT 50%

Sun Diesel Lubricant Eliminates Hard Carbon, Stops Sludging, Ends Costly Bearing Failures

Troubles began to pile up for a company renting out diesel-powered cranes, air compressors, and heavy-duty earth-moving equipment. Piston rings stuck with hard carbon; sludging resulted in clogged oil pump screens, bearing failures, abnormal cylinder wear. As a result there was frequent necessity for complete engine overhauls. Downtime was excessive.

A Sun Diesel Lubricant proved to be the solution to the difficulties. This "Job Proved" Product, recommended by a Sun Engineer, has been used by this concern for two years now. There have been no stuck rings, no bearing failures traceable to lubrication, no clogged oil pump screens. Cylinder wear is at a minimum. General maintenance costs have been reduced 50 percent. Efficiency is way up—to the profit of both owner and users.

Here is another example of what Sun "Job Proved" lubricants are doing to increase the life and efficiency of machinery. By helping to improve output and quality, and at the same time hold costs down, they can play a large part in making operations show a profit. It will pay you to consider how Sun "Job Proved" Products can be used to advantage by your company. Call your nearest Sun Office for complete information.

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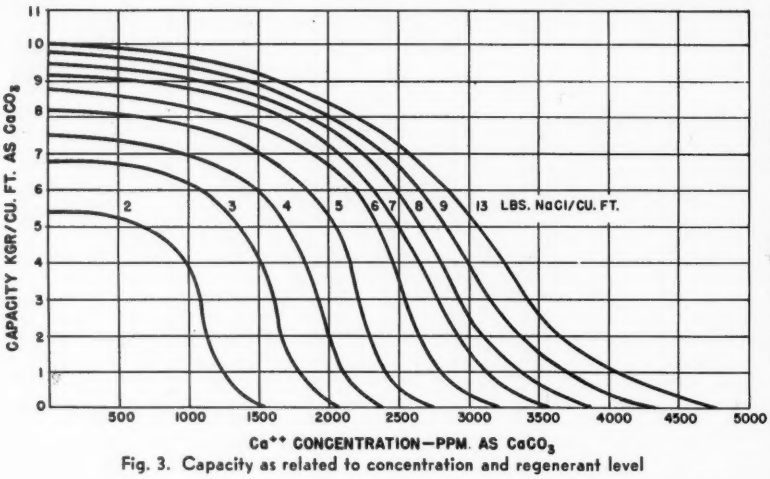


Fig. 3. Capacity as related to concentration and regenerant level

age quality over the entire exhaustion cycle.

Effect of Alkalinity

With water of high alkalinity, little leakage is experienced. The suppression of sodium leakage during the exhaustion cycle by a high ratio of bicarbonate to chlorides and sulfates in the raw water is shown by Fig. 2, in which alkalinity ratio is varied at constant regeneration level. The reduced leakage at high ratios can be explained by the fact that carbonic acid is predominantly formed, whereas there is little formation of hydrochloric or sulfuric acids. This acid is too weakly ionized to displace the unregenerated sodium ion.

Up-Flow Regeneration

To effect the economy of low regeneration level, to prevent varying quality during the service flow, and to maintain a minimum of leakage, up-flow regeneration is suggested. Since normal hydraulic bed classification places the largest resin particles at the bottom of the bed, up-flow regeneration is efficient, because it brings the fresh regenerant into immediate contact with these large, difficult-to-regenerate resin particles. Although this advantage might be minimized by the poorer contact between the resin and regenerant solution noted in upflow regeneration, the leakage of sodium in the effluent is prevented, for the bottom of the resin bed is the most completely regenerated portion. Any sodium ions released by the upper portion of the bad are adsorbed and cannot appear in the effluent.

Hardness Leakage

Calcium leakage depends on regeneration level, concentration, and the ratio of sodium to calcium in the influent. Figure 3 indicates the variation of capacity (kilograins as calcium carbonate per cubic foot of Amberlite IR-100-Na) with calcium concentration (parts per million as calcium carbonate) and the effect of sodium chloride regeneration level on this variation. The capacity is the average to a breakthrough of 5 ppm as calcium carbonate.

From these curves, a revealing balance can be struck between capacity and regeneration level. By dividing pounds of salt per cubic foot used to regenerate the resin, by the exchange capacity (in kilograins per cubic foot) the following comparison can be made at a concentration of 2000 ppm per million as calcium carbonate:

Lb Salt per Cu Ft	3	4	5	6	7	8	9	13
Lb Salt per KGR	30	2.0	0.93	0.88	0.97	1.04	1.13	1.55

This comparison indicates that 6 lb of salt per cubic foot of resin offers the most economic regeneration.

Effect of Sodium-Calcium Ratio

Above 2000 ppm of dissolved solids, the sodium-calcium ratio in the influent becomes more significant. Figure 4 pictures the effect of this ratio on hardness leakage at various regeneration levels, with a water containing 5000 ppm dissolved solids. At all regeneration levels there is a maximum leakage at about 50 per cent calcium.

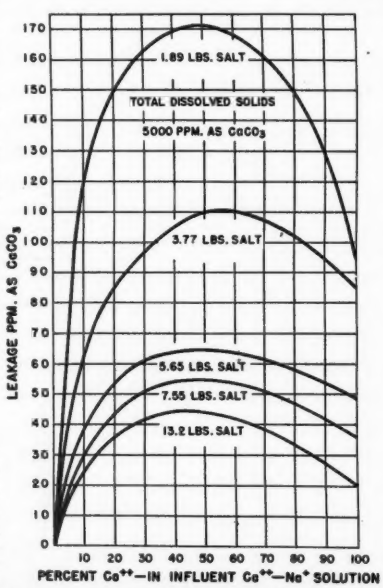


Fig. 4. Hardness leakage related to regenerant level and Na-to-Ca ratio

In the calcium-sodium cycle the magnitude of the leakage is not as great as in the sodium-hydrogen cycle, but the effect of hardness in boiler feedwater is infinitely greater. Figure 4 can be used to advantage to determine what effluent quality can be expected when treating influent water of extremely high cation content.

COAL FREEZING PROOFING AND CORROSION

(Continued from page 58)

cium chloride at normal temperatures, although it may happen in cases where the solution is subjected to heat for long intervals. If conditions are bad, this can happen in domestic stoker screws; but it is not likely to happen in commercial or industrial equipment. Water will react with iron at normal temperatures to form iron oxide or rust. The reaction is electrolytic and complex.

"Any salt or other material that will form an electrolyte helps this reaction to some extent. Thus, calcium chloride is corrosive in that it acts as an electrolyte, as do a number of other substances. Since wet coal will react without it, there is a big question as to how much corrosion to attribute to calcium chloride. In an inside bunker where heat from the boilers dries the coal, or where the metal is swept clean by coal movements, there is likely to be very little. Rusting and wear will take place anyhow; so it becomes a question of which is the worse—the chance of some additional corrosion at times, or frozen coal. In most parts of the north coal needs to be freezeproofed only about four months per year."

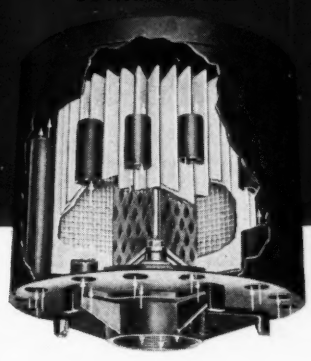
William C. Justice, Hyattsville, Md., portrays the cumulative effect of chloride salts in pointing out that, although it sounds inoffensive to say 2 to 5 lb of calcium chloride per ton of coal, multiplying the total tons of coal handled per season by the basic few pounds per ton, the result gives a staggering amount of chloride from the viewpoint of possible corrosion.

In plant with which Mr. Justice had experience, no holes or badly pitted spots were noted in coal chutes, spreaders or stoker hoppers, which were replaced 3 or 4 years ago after 30 years of service. The metal had thinned by wear, evenly. No calcium chloride freeze-proofed coal had been unloaded during these 30 years.

During the past two winters, calcium chloride freeze-proofed coal,

IT FILTERS!

IT SILENCES!



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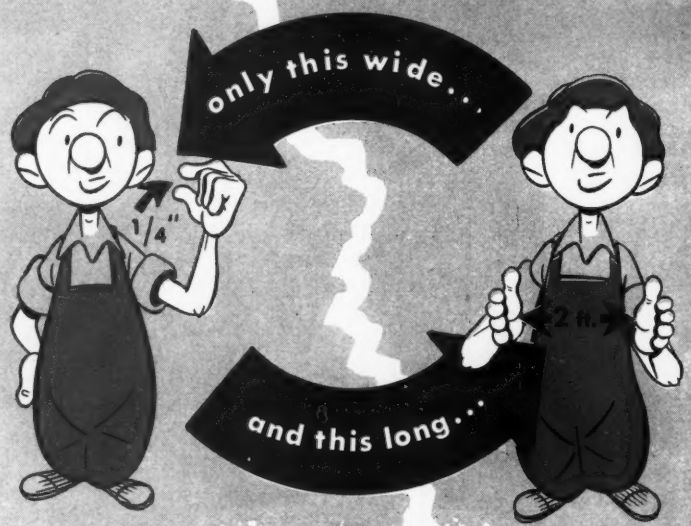

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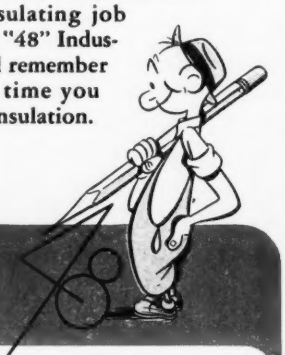

**Calculated for ¼" x 2' crack; hot wall to cold wall temperature differential, 850° F.—giving 5500 B.t.u. loss/hr.; coal: 10,000 B.t.u./lb.*

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of the same characteristics as that received since 1939, was unloaded at this plant. This past summer a number of chutes, spreaders and stoker hoppers have broken out with sizable holes. The holes generally appeared on the under sides of the equipment along the path that water in the coal would be expected to follow. Pitted spots also appeared at the sections of greatest abrasion.

Examination of bulletins of the U. S. Bureau of Mines relating to use of chloride additions in laboratory tests provided the following summaries of pertinent factors:

1:—Bulletin No. 404, dated 1937, using Pittsburgh coal of 2 per cent moisture passing through ¾ in. by 1 in. mesh, using 322 cu ft air per sq ft per hour, in a small test boiler, gave results shown in Table II.

The amount of salts used in the Table II tests, 2 per cent or 40 lb, is approximately twice the normal weight shown in Table I as required to prevent freezing of coal containing 7 per cent surface moisture at -10 F.

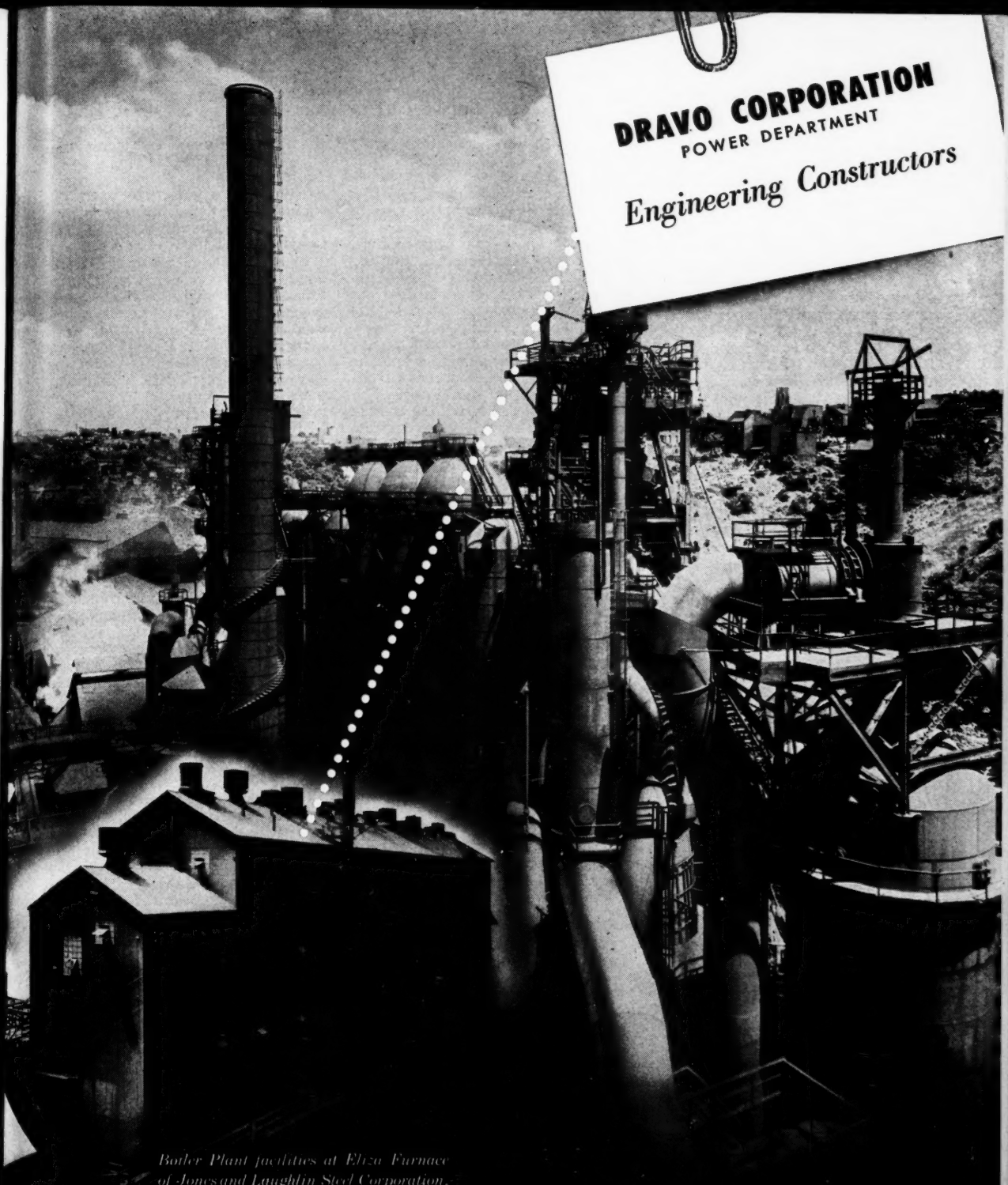
2:—Comments by W. T. Reid, U. S. Bureau of Mines, dated July 19, 1943, on tests run on the screw of a domestic stoker by Prof. W. A. Staab of West Virginia University, using 1¼ in. by ⅜ in. Sewickley coal, indicated losses, in pounds per year, based upon a seven month heating season, as shown in Table III.

The data presented here are considered meager and inconclusive. A need for the pooling of results obtained by users of chlorides or other materials for freeze-proofing coal, with regard to corrosive effects of these materials in large field operations is clearly indicated. This would require considerable time, since the visible effects of these coal additions would not show up for several years.

At the moment, utilities in freezing areas are confronted with the problems presented by modern mining and washing practices. Unloading problems in freezing weather can be mitigated considerably by installing means of thawing the cars, limiting the moisture content of the coal received during freezing periods, curtailing shipments and using coal from storage where stock-piles permit, or other helpful expedients.

The Dayton Power and Light Co. has established the policy for the past winter of not accepting chloride-treated coal and of limiting the acceptable moisture content as close as possible to the percentage inherent in the mined coal.

In concluding, it should be stated that the above study has been made "by excerpt". It is believed that a thorough study of this subject should be undertaken by the A.S.M.E., E.E.I., or other organizations, through their appropriate committees.



Boiler Plant facilities at Eliza Furnace of Jones and Laughlin Steel Corporation, recently enlarged by Dravo Corporation.

DRAVO
CORPORATION
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Engineering Constructors of power plants, boiler plants, central stations, compressor stations, water pumping stations — fabricators and erectors of power piping — power and boiler plant equipment.

Pittsburgh, Philadelphia, Cleveland, New York, Detroit

ATOMIC POWER AND ECONOMIC DEVELOPMENT

(Continued from page 73)

sance in India, or for that matter, in those vast areas of the world which are economically underdeveloped and whose cultures lack aggressiveness.

A few whose cultures have been marked by relatively aggressive traits, but whose economic development has been retarded by poor access to power resources, may, of course, benefit from the extensive development of atomic energy. Argentina is a good example. There is every likelihood that Argentina and other countries in her category will attempt a more extensive industrialization based on atomic power. They may be handicapped by lack of capital but there will be a slow but cumulative growth in their industry as a consequence of the introduction of atomic power.

In the remaining nations, where extensive industrialization is already an accomplished fact, the impact of atomic energy will be collectively unlike that in the nations which have been loosely characterized as non-aggressive culture types.

Certain of the *have-not* nations such as Japan and Italy theoretically, could make good use of atomic power but here the restricting factor is lack of capital—not so much for the construction of the atomic power plants but for the investment in machinery and other manufacturing facilities needed to use the power. These are limiting factors; they do not stand in the way of developing atomic power but they may delay its development for a long time.

Among the *have* nations, some, such as France, hold a marginal position. Their resources are modest and insufficient in themselves to challenge the industrial supremacy of nations whose energy endowment is considerably greater. Other things being equal, it would seem reasonable to expect the achievement of atomic power to improve the status of such a country as France in the hierarchy of industrial nations. Certainly, the differential in power potentialities between France, on the one hand, and Germany, Great Britain, Russia and the United States, on the other, would be narrowed.

Effect of Atomic Power in Britain and Russia

Leaving aside Germany, whose unsettled condition makes future speculation idle, there are three nations remaining which are industrially of first importance, and at the same time, rich in energy endowment. The first of these in Great Britain. Great Britain is a mature economy. Her population is older and seems likely in the next 20 yr to decline more sharply than that of any other European nation except France. Her fuel situation is approaching the critical; her better coal is gone and coal production is running into increasing costs.

Unquestionably, Britain is taxing her energy resources and, as a consequence, will press for atomic power as a relief measure. The fuel costs in Britain are already above comparable levels in the U. S. This will make the extensive use of atomic energy more probable in England than in our own country. Once more, however, the limiting factor is the lack of capital. Not only has she less of it available than has U. S. but, relative to labor, capital is considerably more costly.

The long run effects of atomic power upon the economies of the United States and Russia is of peculiar interest and significance. The U. S. has almost 2½ trillion tons of coal in her reserves. This is from 50 to 100 per cent more than Russia is known to possess. In water power, on the other hand, Russia's resources are more than double our own. In fuelwood and peat, too, Russia outstrips us but to balance these we have superior resources in both petroleum and natural gas. Our total present energy reserves appear to be at least a third greater than those of the Soviet Union. American superiority is further increased by the higher grade of its coal reserves and by their absolute and relative accessibility. Taking into consideration the much greater land area of the USSR, the United States has some four times the energy resources of Russia.

The very fact of Russia's inferior energy resources then will encourage her use of atomic power. Moreover, we should not be surprised if such development, when it does occur, is both more immediate and intensive than in the United States.

There are many other factors to be considered—factors having to do with transport, population growth, etc. Russia's population will continue to increase rapidly long after our own population has stabilized at somewhere around 165 million in 1990. By 1990 indications are that Russia will not only outnumber us but that they will still be increasing toward a peak of 350 million.

Population Factor

Population is important not merely from the point of view of the somewhat problematical military strength. We must recognize too that the exploitation of a new technique, such as atomic energy, is likely to be more intensive where population is growing fairly rapidly. As population increase slackens, as the addition of hundreds of thousands of new customers every decade ends, as industrial empires and monopoly control replace the small enterpriser, as early innovation becomes institutionalized as habitual practices, the earlier flexibility of the economy and its business leadership diminishes. This is even more true of specific industries.

There are plenty of examples. Beginning late in the 19th century, the British iron and steel industry failed almost completely to adopt the newer processes and techniques. It refused to admit the obsolete nature of the old methods to which it clung and it ignored entirely the changing locational strategy of ore and coal deposits and the organizational changes this demanded.

It is more difficult to be frank about our own economy in our own time. Such frankness will demand recognition of growing arteriosclerosis in major sections of our own industry. Our iron and steel industry shows evidence of increasing conservative leadership in its reluctance to risk expansion in the early years of the recent war and in the early post-war period. There is strong suggestion in all this that American business leadership is by degrees assuming the more conservative position characteristic of British enterprise at the peak of its economic ascendancy.

Meanwhile, as Blackett specifically notes, Russian business leadership, for the most part embodied in the State, reflects the immature economy and the growing population of that country. It appears imbued with the spirit of aggressive risk-taking which characterized American or German business leadership at the end of the 19th century. To the extent that this is true, American development of atomic energy as a power source is likely to be pushed less vigorously than that of Russia.

In face of multiple human variables, conclusions about the future can never be absolute. It is a conservative view, however, that the energy resource position of the United States relative to that of Russia will deteriorate. In other words, atomic power will probably prove in the long run a greater addition to the energy resources of Russia than to those of the United States.

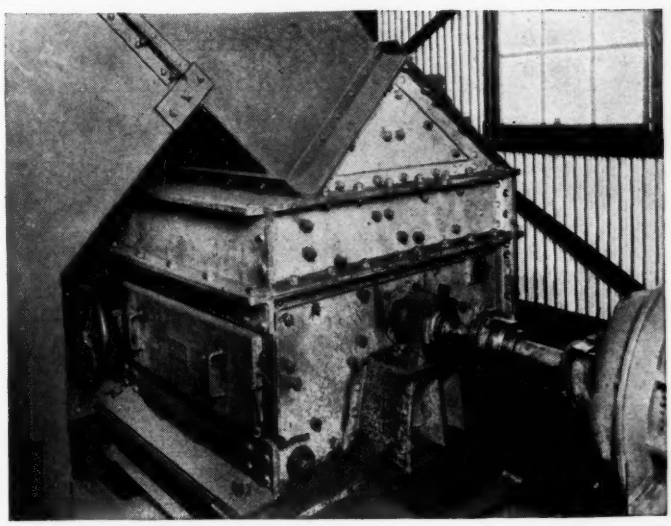
So far as the long-run economic consequences of atomic energy for the U.S. and Russia go, Professor Blackett is essentially correct but it is more difficult to predict short-run and middle-run developments. And it is these which are of crucial importance in the determination of policy aimed toward international control of atomic research and implementation.

It is in this appraisal of the situation that Blackett treads on thin ground. He infers that the utilization of atomic power will permit Russia, like India, to make short-run gains sufficient to effect a considerable narrowing of the gap in energy resources between the two countries in a relatively brief period of time. Intelligent study of all factors, economic, social and technological indicate this inference may prove wrong in the years to come.

Why the PENNSYLVANIA GRANULATOR GIVES YOU LESS OVERGRINDING and MORE GRANULATION

Even though the "crushability" of some coal is very high, the Pennsylvania Granulator (because of its design and slow speed) produces less extreme fines than conventional types. This is due to the exclusive Pennsylvania reduction principle that causes the rings to reduce the oncoming feed by a rolling compression, greatly diminishing the attrition or "scouring action", thus giving a more granular, free flowing product.

We have a bulletin that describes this principle in detail. Just drop us a line and we'll send it along. Incidentally, Pennsylvania Granulators are equipped with a non-magnetic, non-power-using Separator that automatically traps tramp iron and other metallics.



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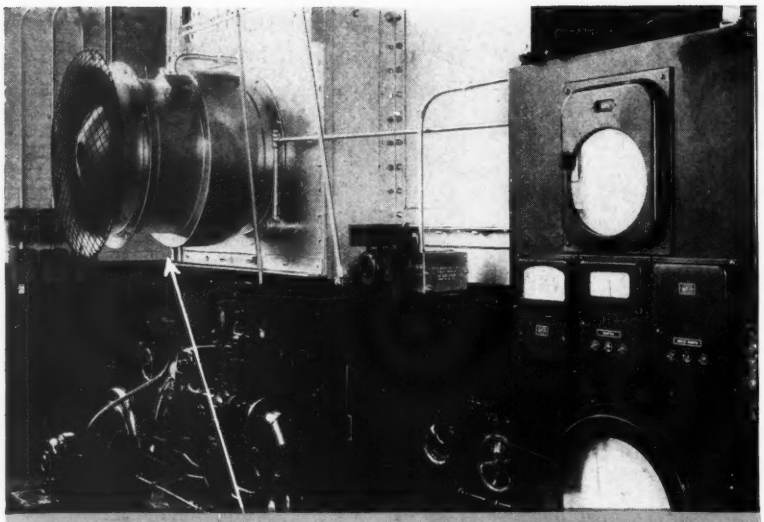
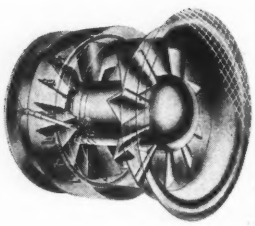


The Wing Blower is "working out to the fullest satisfaction of everyone"



Wing EMD Blower showing simple design and built-in volume control. Internal radial dampers are actuated by an external balanced lever. Can be adjusted manually or by combustion controls.

That comment "to the fullest satisfaction of everyone," quoted from a recent letter, is characteristic of Wing Blower installations. For these Axial Flow Blowers are *built* to give satisfactory performance . . . simple and rugged construction, compact design with built-in capacity regulating dampers, combining high efficiency with quiet performance. Installation costs, too, are low. Write for descriptive bulletin or specific details.

L. J. Wing Mfg. Co. 64 Seventh Ave., New York 11, N.Y.
Factories: Newark, N.J. and Montreal, Canada

Wing

AXIAL FLOW BLOWERS

OIL SYSTEMS

(Continued from page 61)

The auto-ignition temperature of turbine oils is from 650 to 700 F. (The auto-ignition temperature is the lowest temperature to which a mixture of flammable vapor and air or a surface exposed to the mixture must be heated to ignite the mixture in the absence of a spark or flame).

Inlet steam temperatures in modern industrial turbines are from 750 F to 1000 F. Oils coming in contact with surfaces at these temperatures will ignite.

Turbine manufacturers, recognizing that a fire hazard exists, have designed the oiling system so that oil pressure piping and joints adjacent to the hot steam parts are either in the oil tank or in return oil lines that drain into the oil tank.

The operator should see that oil is kept off the hot surfaces. Particular care should be used to prevent the possibility of a stream of oil coming in contact with the hot surfaces.

Oxidation and Stability

During the foregoing, reference has been made to oil oxidation and to oxidation products. Turbine oils are refined so as to retain primarily those molecules which are stable; i.e., which do not combine readily with other molecules, such as oxygen, sulphur, and the like. The combination of petroleum molecules with oxygen produces other products, which have an acid reaction. The acid number is used, therefore, as a measure of the amount of oxidation products present.

In the non-inhibited turbine oils, the acid number of the oil in service may raise continually. This is also true of oxidation-inhibited oils after the inhibitor is used up.

Figure 1 is a plot of acid number over a period of years of an oil in service in a turbine in the Eastman Kodak Co. plant in Rochester, N. Y. C. L. Pope of the company reports that "the acid number was the most significant physical change; but by the time there was a break in the curve, sludging had commenced. The correlation between the rapid rise in acid number and the sludging was obtained by noting the increase in water to the cooler in order to maintain safe operating oil temperatures. When the turbines could be spared, varnish and rust deposits were such that the governor pistons had to be driven out with wooden blocks and the overspeed trip mechanism was entirely inoperative."

Mr. Pope's story tells of the results of deposits from rust and the products of oxidation.

(To be Continued)

* * *

Another automotive gas turbine has recently been announced, weighing 150 lb and designed to develop 200 hp. Details of the new engine were presented by Boeing Aircraft Co. recently at the annual meeting of the SAE in Detroit.

How to keep purchased power under control...

Ohio leather manufacturer keeps efficient balance between generated and purchased electric power with Worthington turbine-generator unit.

At the Ohio Leather Company, Girard, Ohio, purchased power is kept under direct control by means of a steam turbine generator unit which operates as a "reducing valve" to bring boiler pressure down to required levels for use in plant processes.

The turbine, a Worthington 750 KW straight non-condensing type, operates in parallel with the source of purchased power and has an automatic governor control responsive to both purchased or primary power and to plant demands for processing steam. This results in:

- limiting the *maximum* demands on purchased power to a predetermined top level, regardless of plant steam demands.
- limiting the minimum demands to a level which will prevent return flow of power to primary source when plant steam demands are high and power demands low.

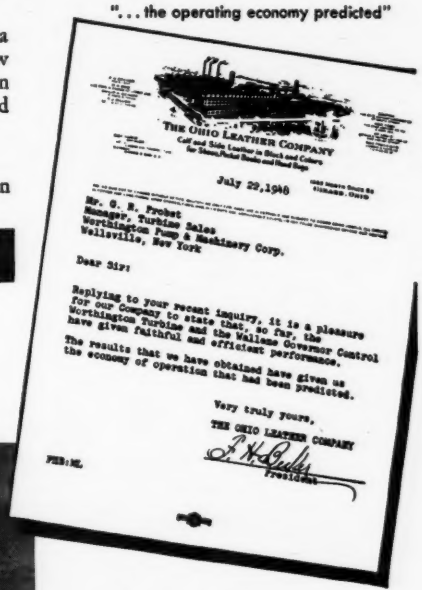
SAVE WITH WORTHINGTON

Savings to date on this installation are at a rate indicating 100% return on the initial investment in three years! For further details that prove *there's more worth in Worthington*, call your nearest Worthington District Office. . . . or write direct to *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, New York.*

WORTHINGTON

STEAM TURBINES

"... the operating economy predicted"


THE OHIO LEATHER COMPANY

July 29,1948

Mr. G. H. Probst
Manager, Turbine Sales
Worthington Pump & Machinery Corp.
Wellsville, New York

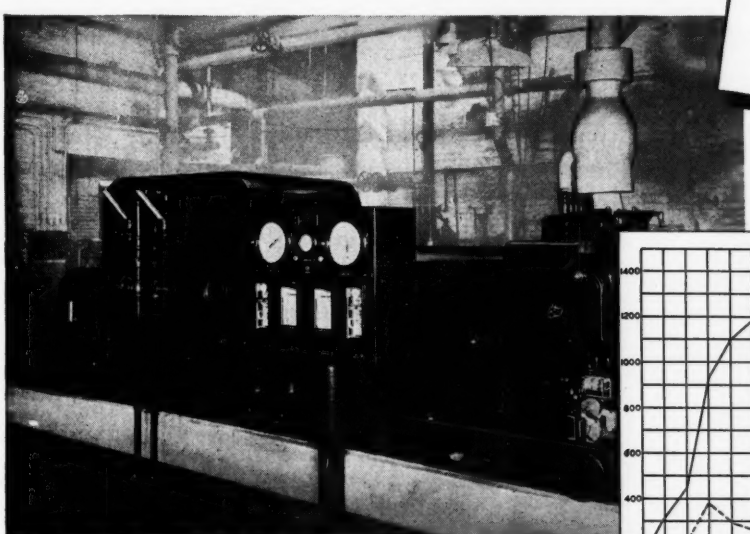
Dear Sir:

Replying to your recent inquiry, it is a pleasure for our Company to state that, so far, the Worthington Turbine and the Wallene Governor Control have given faithful and efficient performance.

The results that we have obtained have given us the economy of operation that had been predicted.

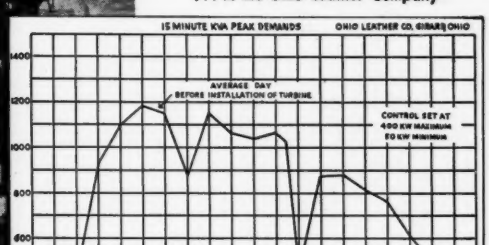
Very truly yours,
THE OHIO LEATHER COMPANY
F. H. Culley
President

FHB:ML



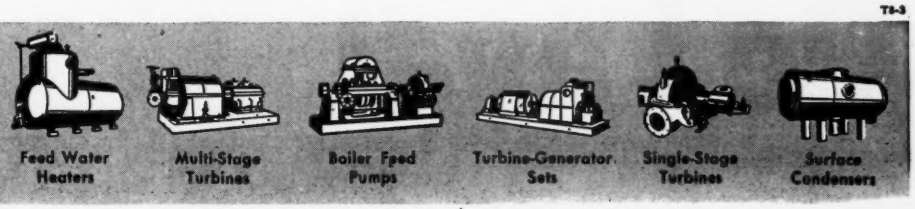
The Ohio Leather Company installation is a direct-connected turbine generator unit, 750 KW, 3600 rpm, 240 volt 3 phase 60 cycle. Steam conditions are 240 psi, 450° F, exhausting at 5 psig. Controls are by Wallene Engineering Co., Cleveland, Ohio.

"BEFORE AND AFTER"
... at the Ohio Leather Company

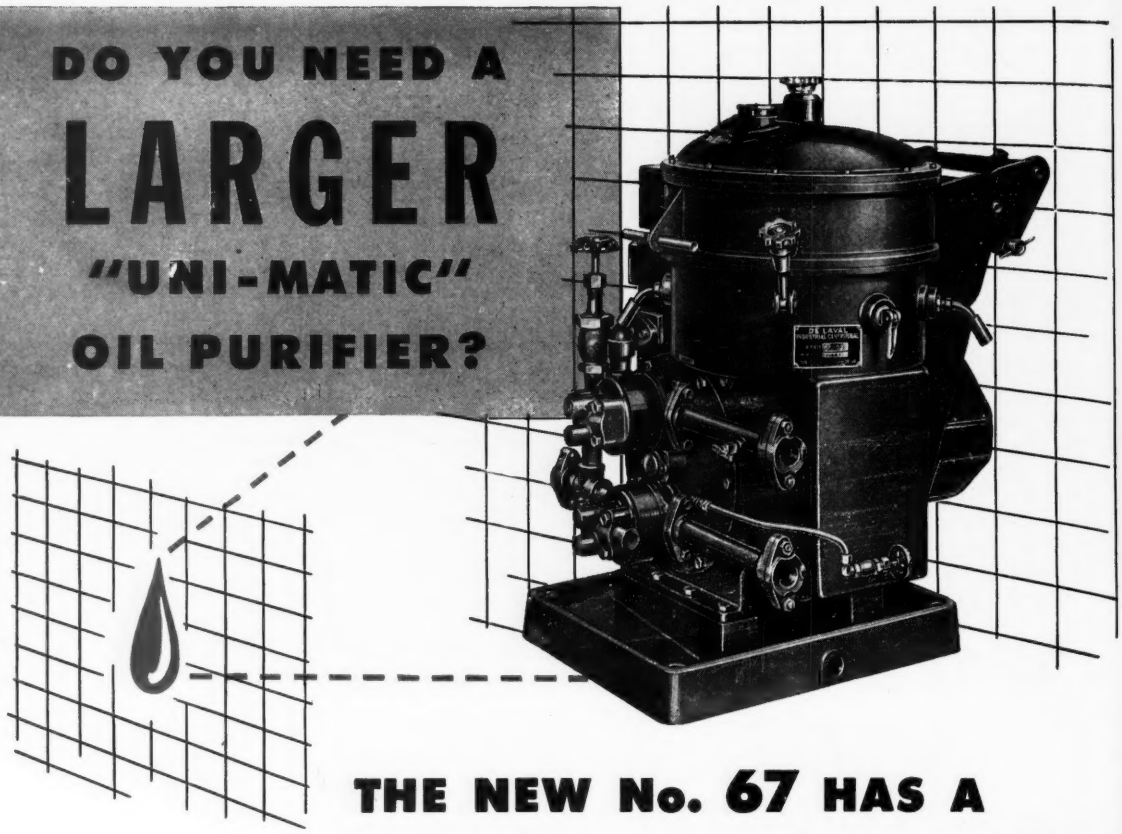

15 MINUTE KVA PEAK DEMANDS
OHIO LEATHER CO. GIRARD OHIO
AVERAGE DAY BEFORE INSTALLATION OF TURBINE
CONTROL SET AT 400 KW MAXIMUM 50 KW MINIMUM
AVERAGE DAY AFTER TURBINE INSTALLATION
1400
1200
1000
800
600
400
200
0
8AM 7 8 9 10 11 12 1 2 3 4
TURBINE IS OPERATED 10 HOURS PER DAY 5 DAYS PER WEEK
DESPITE SHORT OPERATING TIME-UNIT WILL PAY OUT IN LESS THAN 3 YEARS

T8-3

A GREAT TEAM IN STEAM



DO YOU NEED A LARGER "UNI-MATIC" OIL PURIFIER?



THE NEW No. 67 HAS A CAPACITY OF 450-550 G.P.H.

Now it is possible to obtain a larger De Laval "Uni-Matic" Oil Purifier than has ever been available before. The new No. 67 has a capacity of approximately 450 gph. (Navy rating) when purifying turbine oil. On other oils, the capacity of the No. 67 will vary from 200 to 550 gph. depending on the viscosity and temperature of the oil being purified.

A De Laval "Uni-Matic," whatever its size, is a complete oil purification unit consisting of a De Laval centrifugal machine with integral pumps, and, where desired, with heater. ***All*** De Laval machines make most effective use of centrifugal force to remove both of the chief contaminants of oil—***water*** and ***dirt***—and do it so completely that bearings receive the ultimate in protection, and fuel oil yields maximum B.T.U. value.

- ***Write for Bulletin MU-1.***

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LUBRICATING OIL PURIFIERS

TUBE-TURN

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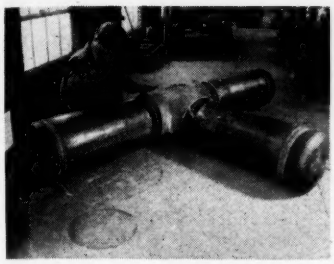
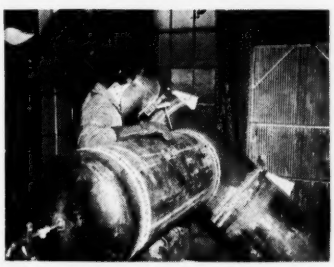
WELDING FITTINGS
AND FLANGES

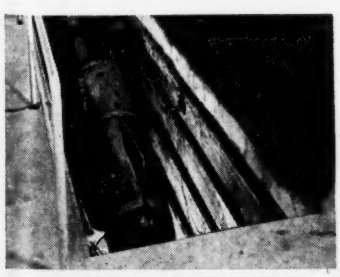


18-inch standard weight Tube-Turn welding tee and pipe laid out preparatory to assembly for hydrostatic pressure test.



Welder completing last bead in assembly. Fitting and pipe now form homogeneous, leakproof unit.

Assembly is hung in pit, massively lined with concrete. During test top grating is closed and held down by a barricade of sandbags.



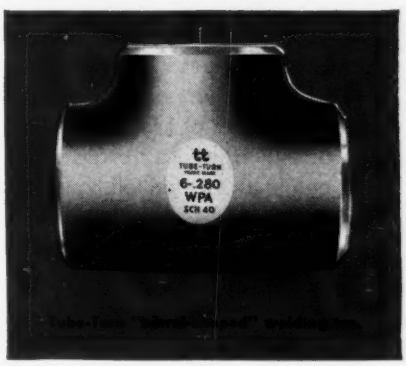
Final result after hydrostatic pressure test. The straight pipe burst first, and the tee is undamaged.

Strength through Design in Tube-Turn welding fittings

The pipe burst first!

Take an 18-inch standard weight welding tee. Take three corresponding lengths of pipe. Weld tee and pipe together. Cap the ends. Lower the assembly into a pit. Then apply hydrostatic pressure—much more than the assembly is supposed to take!

Something has to give! According to the accepted beliefs it should be the tee. But not in the case of the test pictured here. The Tube-Turn "barrel-shaped" tee was used—and the pipe burst, well before the tee was affected! Throughout numerous tests, this new type of tee has withstood at least 25 per cent more pressure than required by the formula given in ASA B16.9.



The superior strength of the tee was achieved without running up extra weight and cost, by carefully planned improvements in shape (based on the sphere, nature's strongest form for internal pressure), and by a carefully engineered distribution of metal.

This is a typical example of *strength through design* in Tube-Turn welding fittings, and another good reason why leading piping engineers specify Tube-Turn equipped, welded piping.

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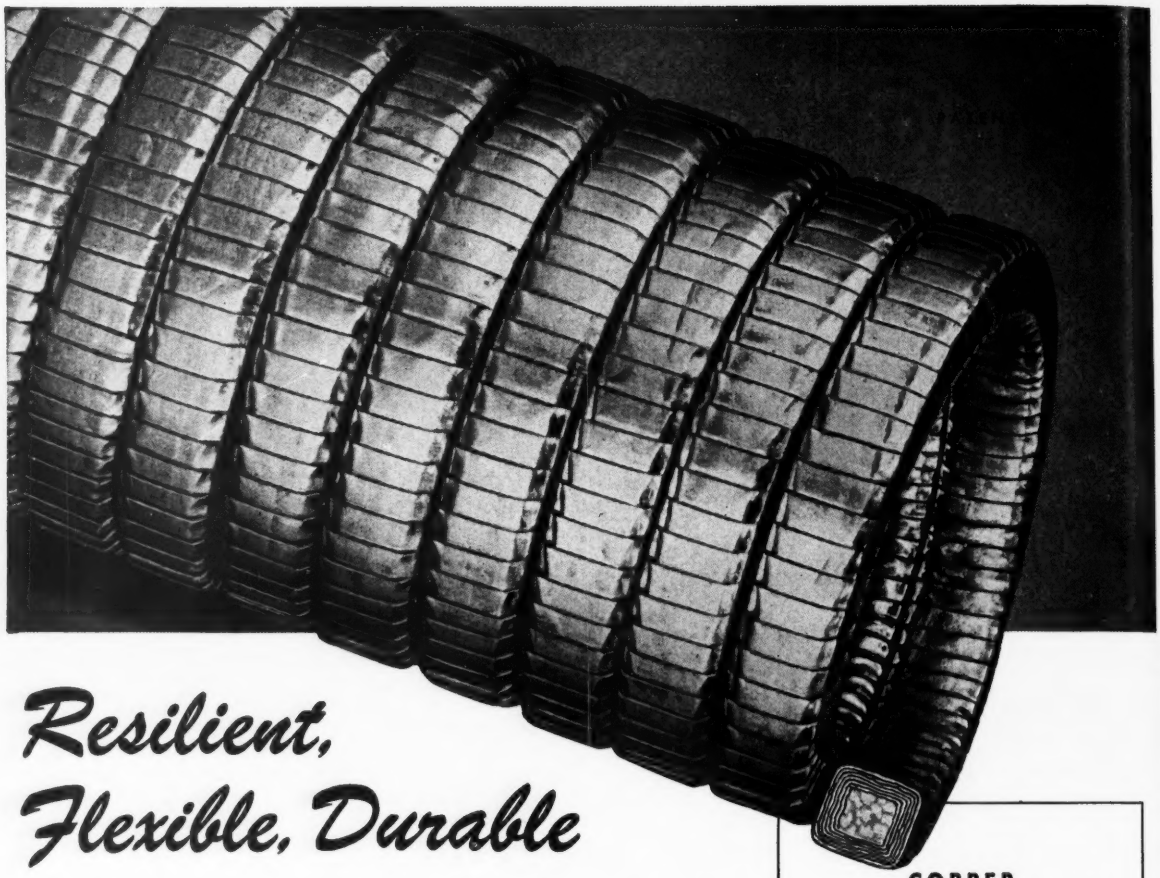
District Offices at New York, Philadelphia, Pittsburgh, Chicago, Houston, Tulsa, San Francisco, Los Angeles



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A patented, pleated foil construction used in several of these new Garlock packings imparts unusual flexibility to the packing and permits the forming of rings without undue distortion of the material. Also the many small pockets in the pleats or folds of the foil carry lubricant or graphite to the wearing surface of the packing.

Garlock Metal Foil Packings are recommended for centrifugal or reciprocating pumps, compressors, engines, expansion joints, etc. Write for descriptive folder.

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GARLOCK 906—Pleated copper foil with asbestos core for steam, air or gases (except ammonia) and hot oils of low sulphur content, at temperatures up to 1000° F.

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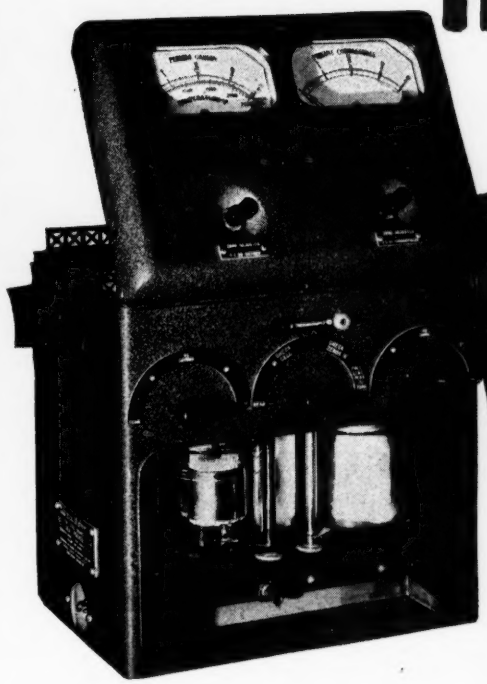
GARLOCK 913—Pleated aluminum foil with asbestos core for hot oils at temperatures up to 1000° F.

LEAD

GARLOCK 917—Pleated lead foil with asbestos core for steam, air, oil, water, ammonia or other gases at temperatures up to 550° F.

GARLOCK METAL FOIL PACKINGS

this unique instrument



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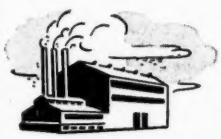

"Using the identical equipment, the same type of fuel, and at no extra cost—we increased our power output as much as we might have gained with an additional new unit. We accomplished this with a few simple adjustments which we made upon the advice of a Cities Service representative after an analysis with the Industrial Heat Prover."

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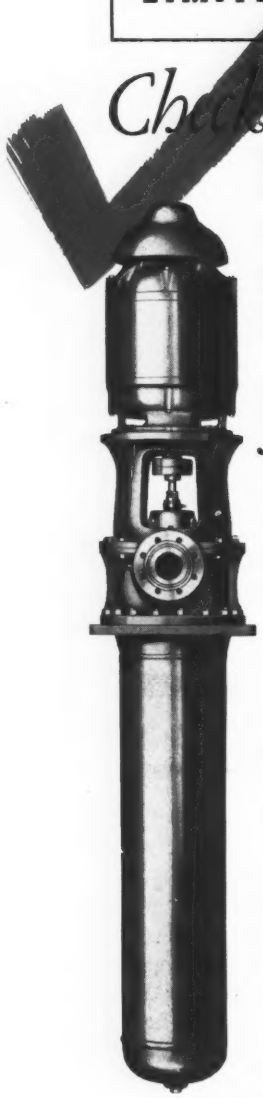

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V-3

ENGINEERS' PREVIEW

EFFECT OF mechanical working on the physical properties of lubricating greases, investigated by S. A. McKee and H. S. White of the National Bureau of Standards, has led to the development of an apparatus for working the grease and measuring its flow characteristics in the same series of operations. Data obtained with the new worker consistometer indicate that the apparatus may provide a valuable tool for the study of lubricating greases. Principal advantages are its flexibility, wide range of shear and consistency measurements, short test cycle, simplicity of design, and, in particular, its provision for characteristic flow data while working under controlled conditions. In addition to the application to greases, Bureau engineers have used the apparatus to determine the apparent viscosity of rubber solutions at different rates of shear and temperature.

The worker consistometer is composed essentially of two coaxial steel cylinders mounted vertically with a capillary-type shearing element between. Close fitting pistons force the grease under test through the shearing element in either direction from one cylinder to the other. While making flow measurements, dead weights are used on the down-stroke of the pistons and air pressure on the up-stroke. Provision is also made for automatic mechanical working.

Various shearing elements can be used and are made by drilling holes in circular steel disks ¼ in. thick, giving capillaries ¼ in. long and approximately 0.015 in. in diameter. In order to cover a range of consistencies, one element has one hole, a second has ten, and a third, fifty holes. Flow through the shearing element is measured and plotted against pressure and temperature; relations between viscosity and results of working the grease and other characteristics may be obtained.

★ ★ ★

TEN MOST IMPORTANT advances made during 1948, picked by Watson Davis, director of *Science Service*, as recently reported in the *New York World Telegram*, are:

1. Creation artificially, in world's largest cyclotron, of sub-atomic particles, called mesons, that may unravel mystery of composition of matter.

2. Achievement by jet plane of speed well beyond the sonic barrier, opening a new air age.

3. Demonstration that a single penicillin pill, swallowed a few hours after exposure, can prevent one of the two major venereal diseases, gonorrhea.

4. Synthesis of glycerine from petroleum, making its commercial production independent of fat supply.

5. Discovery of auremycin and polymyxin, drugs effective against diseases unconquered by sulfa drugs and other antibiotics.

6. Completion of the 200-in. world's largest telescope on Mt. Palomar, Calif.

7. Authorization of two gigantic atom smashers, to produce (three to five years hence) sub-atomic "bullets" rivaling cosmic rays, vastly extending scope of nuclear physics.

8. Commercial production of "low-temperature" rubber, giving chemical rubber superiority over natural rubber.

9. Discovery of the fifth moon of the plant Uranus, with 30-hr orbit.

10. Use of neutrons to explore the structure of matter by production of diffraction pattern photographs.

Important points to know about COTTRELL *Electrical Precipitators*

A COTTRELL Electrical Precipitator is a major plant investment. Once installed it is operated over a period of many years, *thus multiplying year after year the benefits of top notch design and installation.*

And because of the many factors affecting the operating and collecting efficiency of a COTTRELL Precipitator, probably in no other field do the experience and "know-how" of the organization designing and installing the unit play a more important role in influencing the overall performance of the installation. That is why it is so important to remember this fact . . .

Western Precipitation Corporation is the organization that installed the first successful COTTRELL *Precipitator over 39 years ago, still operating efficiently . . . and has consistently developed new refinements, new techniques, new applications that today have made it world famous in the science of recovering dusts, fly ash, mists, fogs and other suspensions from gases.*

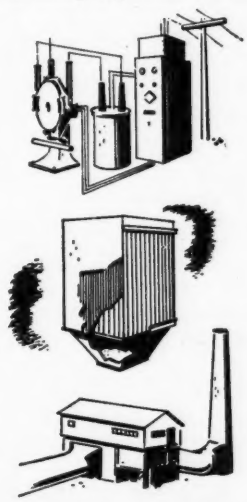
This is the first of a series of advertisements briefly outlining the important elements that go to make up a COTTRELL installation. Only long experience coupled with highest engineering ability, can assure the proper combination of these elements into a COTTRELL installation best suited to *your particular requirements*!

Basically, a Cottrell Precipitator consists of three major divisions each in turn consisting of many separate elements . . .

1. THE ENERGIZING SYSTEM, as its name implies, is the portion of the unit wherein the power is brought in, the voltage stepped up, then rectified to provide the unidirectional high voltage current supply for the Electrode System.

2. THE ELECTRODE SYSTEM consists of the high-tension ionizing electrodes and collecting electrodes through which the suspension-laden gas is passed to be cleaned. These electrodes can be of various designs, shapes and patterns and are equipped with various "rapper" arrangements which assist in keeping the electrodes clean of recovered materials.

3. THE HOUSING OR SHELL includes the structure containing the Electrode and Energizing Systems as well as the gas ducts and distributing system, the hoppers for receiving the collected material and other miscellaneous equipment.



Each of these three major divisions, together with their many individual parts, must be carefully engineered into ONE integrated and precisely-balanced unit to provide the successful and continuously-operating COTTRELL Precipitator. This series will take these major units apart to show in greater detail how the individual parts function and the varying types of design and construction. Watch for them.

10 COTTRELL ADVANTAGES

that make Cottrells unsurpassed for all types of recovery problems, hot or cold, wet or dry

1. **LOWEST DRAFT LOSS** — only a few tenths of an inch w. g.
2. **LOWEST POWER COST** — only ½ to 1 kwh. per 100,000 cu. ft. of gas cleaned.
3. **LOWEST MAINTENANCE COST** — all metal, few moving parts, no fire hazard.
4. **LOWEST LABOR COST** — operation can be fully automatic, if desired.
5. **LONGEST LIFE** — early Cottrell installations still operating after 39 years of continuous service.
6. **HIGHEST EFFICIENCY** — recovery efficiency approaches 100%, if desired.
7. **UNIVERSAL APPLICABILITY** — recover any suspension, solid or liquid — in any gas — over wide temperature ranges.
8. **ANY CAPACITY** — handle a few c.f.m. — or millions — with equal ease.
9. **MAXIMUM FLEXIBILITY** — readily adaptable to varying installation requirements.
10. **LOWEST OVERALL COST** — cost less per year of service, less per ton recovered. Often pay for themselves in a few months — always within a few years.

Do You Have This Helpful COTTRELL Booklet? In 28 pages of interesting charts, illustrations and descriptive data, it answers many of the questions engineers ask about COTTRELL design and construction. Send for your free copy. Ask for Bulletin C103!

WESTERN Precipitation CORPORATION

ENGINEERS, DESIGNERS & MANUFACTURERS OF EQUIPMENT FOR COLLECTION OF SUSPENDED MATERIALS FROM GASES & LIQUIDS

Main Offices: 1029 WEST NINTH STREET, LOS ANGELES 15, CALIFORNIA
CHRYSLER BLDG., NEW YORK 17 • 1 LaSALLE ST. BLDG., 1 N. La SALLE ST., CHICAGO 2 • HOBART BUILDING, SAN FRANCISCO 4, CALIFORNIA
PRECIPITATION CO. OF CANADA, LTD., DOMINION SQ. BLDG., MONTREAL

When you buy a boiler, do you surrender your right to choose the stoker?

If you are considering the purchase of a new boiler, make sure you *retain* the privilege of selecting the Spreader stoker of your own choice. And look *closely* at Spreader stokers! Be certain you get these 4 features: 1. *Clogless feeding* of wet or dry coal; 2. *Even* coal distribution; 3. A cinder return system that works; and 4. *Adjustable* overfire air.

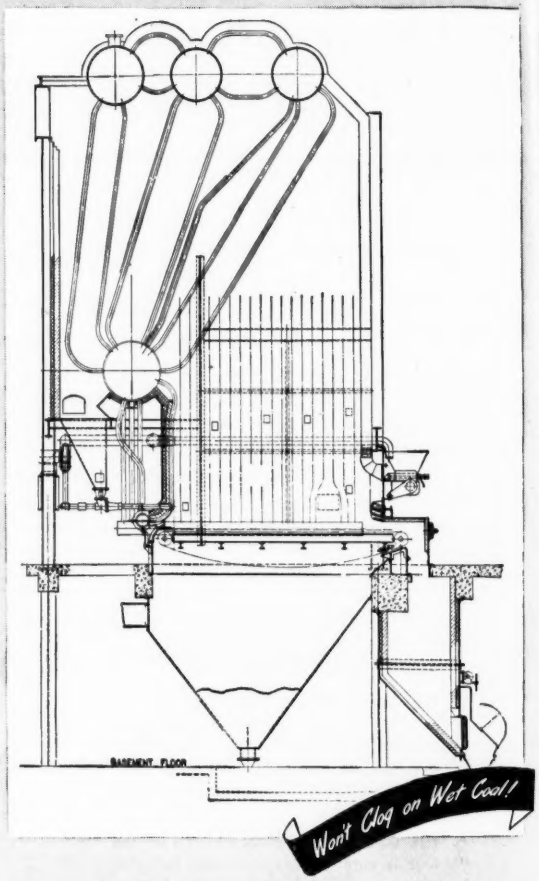
With Æ Perfect Spread Stokers, you are sure of all four—*and more.* The exclusive feeder handles coal at a rate adjustable from 50 to 7500 lbs. per hour; the overthrow impeller was developed—after experience with many designs—to spread the coal evenly. *Individual* cinder returns tap *every* cinder drain point. Each return has its own Venturi air jet to the furnace. And every overfire air nozzle is adjustable.

You can burn less costly lower grade coal efficiently, reliably and with better control of stack discharge.

Besides these 4 big features there are many more that make the Æ Perfect Spread Stoker the standard of comparison for engineering, construction, operation, performance and economy.

No matter who supplies your boiler, *insist* that an Æ Perfect Spread Stoker be installed. Full details are contained in our new illustrated catalog. Send for your free copy today.

FREE! *Get this informative catalog on Æ Perfect Spread Stokers now. Write Dept. 12.*



1948 Æ Perfect Spread Stoker installation in the Ohio plant of a large automobile manufacturer. It consists of 4 Æ Perfect Spread Stokers, of the Continuous Ash Discharge type. Each unit has a normal capacity of 60,000 lbs. per hour, and maximum capacity of 70,000 lbs. per hour steam output.

OTHER Æ PRODUCTS—*Taylor Stokers—Lo-Hed Electric Hoists & Car Pullers—Hele-Shaw Fluid Power—Marine Deck Auxiliaries.*

Æ PERFECT SPREAD STOKER

with Traveling, Dumping or Stationary Grates

A PRODUCT OF

AMERICAN ENGINEERING COMPANY

2408 Aramingo Avenue, Philadelphia 25, Pa.

New York Office—75 West Street, N.Y., N.Y. • *In Canada:* Affiliated Engineering Corporations, Limited, Montreal and Toronto

You're sure to have *Better, Safer* boiler water level supervision with Reliance EYE-HYE

Remote Indication Saves Time—Increases Efficiency

YOU SAVE precious seconds—often many dollars—by reading boiler water levels in the EYE-HYE, without tedious dangerous climbing to high boiler gages. An EYE-HYE for each boiler, mounted on your panel board, gets a glance every time instruments are checked—a sure way to catch wasteful or hazardous feed water conditions.

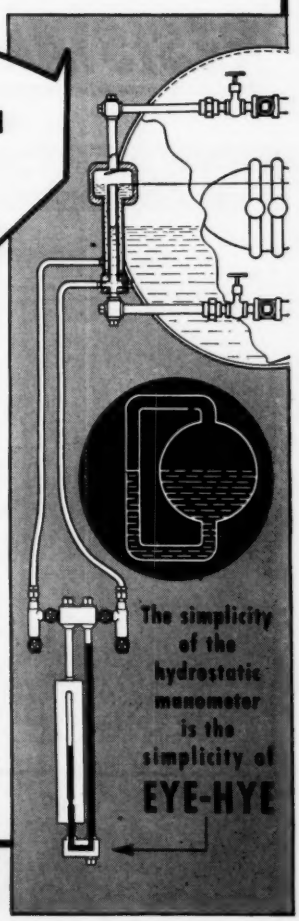
Brightly illuminated green fluid arrests every operator's eye. EYE-HYE's accuracy and dependability resulting from its simple hydrostatic principle and rugged construction are praised by thousands of engineers. It can't be tampered with in service; easy to install; practically no maintenance. Write or call your nearest Reliance Representative.

Reliance UNITEMP—complete temperature equalizing unit—furnished with each EYE-HYE

UNITEMP maintains an even temperature in both hydrostatic legs, thus assuring EYE-HYE's accuracy. It's furnished as original equipment with each EYE-HYE—a *complete unit*, ready to install with small expense for fittings.

EYE-HYEs for all types of service

EYE-HYE models cover all pressure situations, from lowest (even at vacuum) to as high as 2500 psi. Checking levels in auxiliary vessels such as feed water heaters and surge tanks is made faster and more convenient by models especially adapted to that purpose, with graduated face plates if you want them. One EYE-HYE model measures liquid level variations as large as *12 feet.*

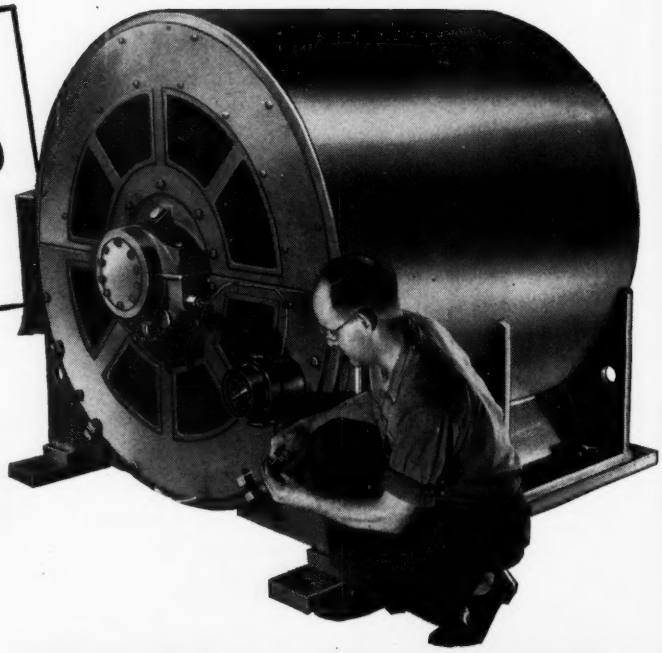


BOILER SAFETY DEVICES since 1884

Reliance

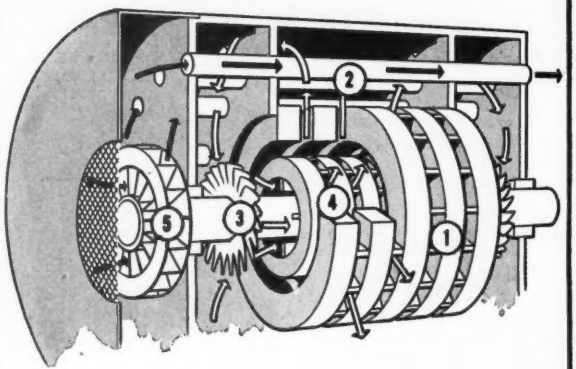
THE RELIANCE GAUGE COLUMN CO. • 5902 CARNEGIE AVENUE • CLEVELAND 3, OHIO

TUBE-TYPE
TOTALLY-ENCLOSED FAN-COOLED MOTORS!



DIRT-
AND CORROSION-RESISTANT!
PROOF!

How Tube Cooling Works



Stator core (1) is surrounded by tubes (2). Internal fans (3) circulate air through ducts (4) in rotor and stator and around tubes, transferring heat to tubes. External fan (5) drives outside air through tubes, removing heat and keeping tubes clean. All electrical parts are enclosed. Dirt cannot enter.

*Totally-Enclosed Fan Cooled

- **Install anywhere – indoors or out**
- **Heat exchanger is practically *self-cleaning***
- **Sizes . . . 75 to several thousand horsepower**

THIS ALLIS-CHALMERS tube-type TEFC* motor practically eliminates cleaning and other high maintenance costs associated with large motors exposed to dirty and corrosive atmospheres. And it does this with a simple, self-contained, tube-type, ventilating system.

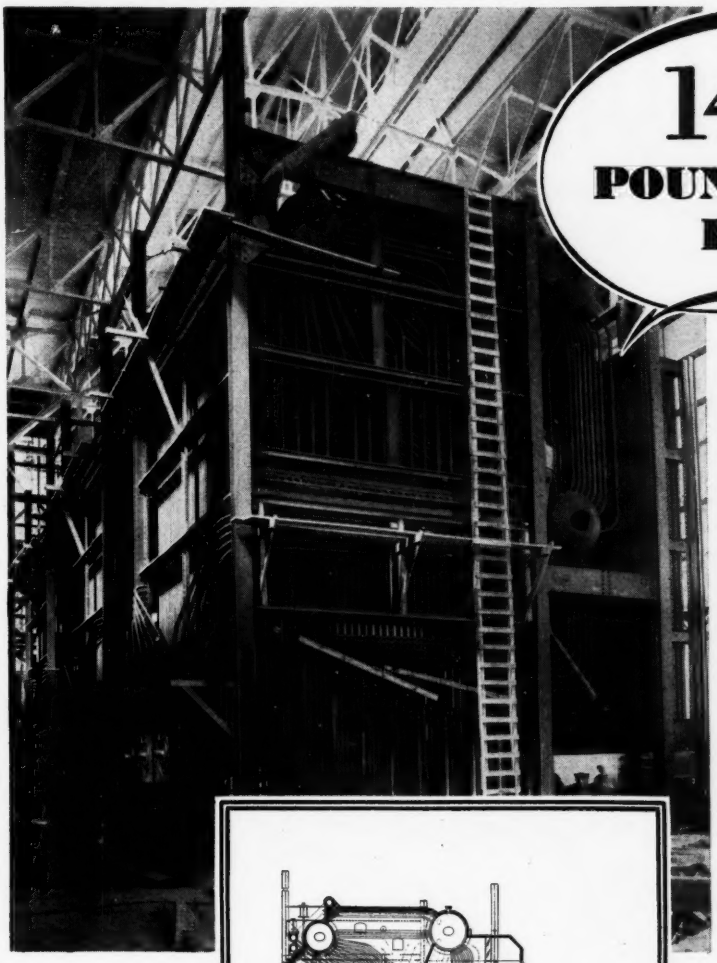
All electrical parts — including the stator core — are enclosed. The simple heat transfer system keeps temperatures well within rated limits. Cleaning is rarely needed because air passages are unrestricted. Air flow through the straight tubes removes foreign matter.

Three years of field operation have proved important savings. Sizes from 75 hp and up. Also explosion-proof designs. For complete information, outline your requirements to your A-C Sales Office, or write for Bulletins 05B7150 and 51R7149.

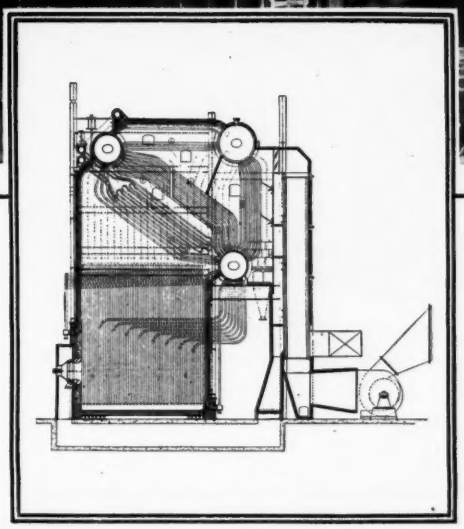
A 2664

ALLIS-CHALMERS, 953A SO. 70 ST.
MILWAUKEE, WIS.

ALLIS-CHALMERS



140,000
POUNDS OF STEAM PER HOUR



Number of Erie City Steam Generators.....3

Pounds of Steam/Hr..140,000

Design Pressure.....450 lbs.

Operating Pressure...425 lbs.

Steam Temperature..725° F.

Heating Surface—
Erie City Boiler
12,610 Sq. Ft.
Erie City Water Walls
2,312 Sq. Ft.
Erie City Air Heater
12,000 Sq. Ft.

Final Exit Gas Temp..401° F.

Method of Firing
Gas and Oil

STEAM POWER PLANT EQUIPMENT

Complete Steam Generators • Type C 3-Drum Boilers • Type VL 2-Drum Boilers • The "Economic" Boiler with or without Water Walls • Welded H. R. T. Boilers • Welded Steel Heating Boilers • Coal Pulverizer • Underfeed and Spreader Stokers • Welded Pressure Vessels for the Process Industries.

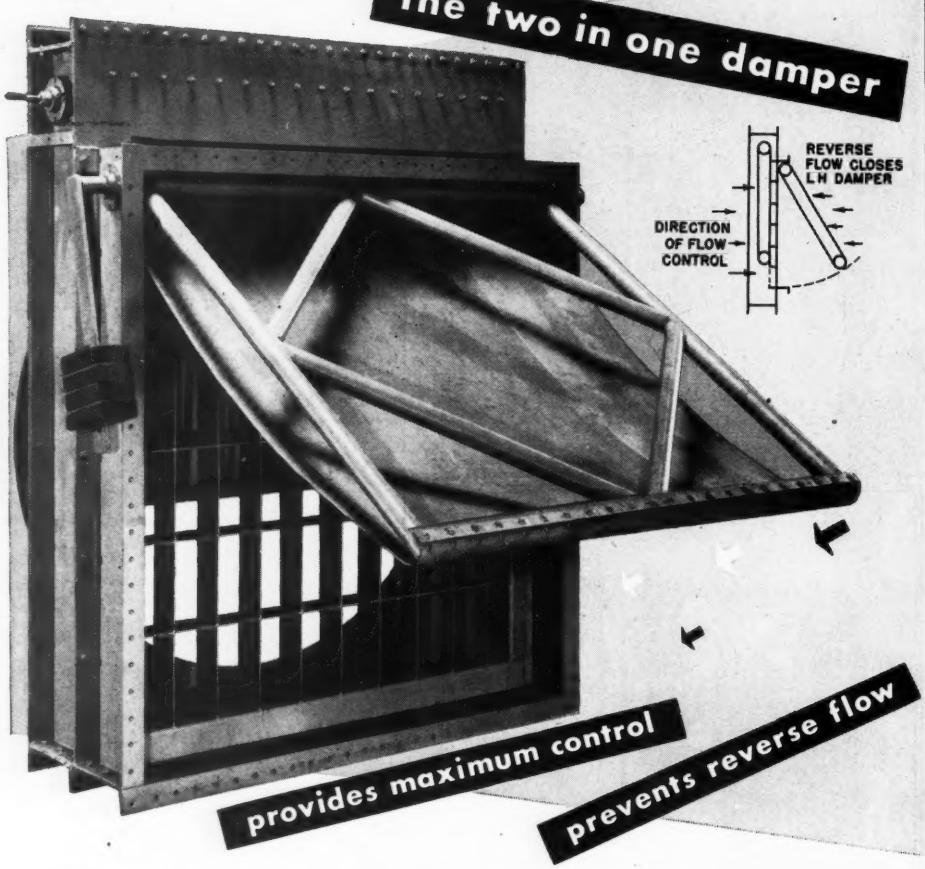
ERIE CITY SINCE 1840

ERIE CITY IRON WORKS • ERIE, PA.

HEACON DAMPERS

for unique applications

the two in one damper



Variations in design of Heacon Dampers are made when specific applications make them necessary. One of the most unique dampers developed for special application is the double duty Heacon Damper here illustrated.

This unit was designed to operate in tandem with two others, for the control of 3,000 h.p. blowers. It is actually a combination of two types: the SVH, seen partially closed through the grill, for regulating flow, and the LH, or leaf type, shown in open position on near side. This LH damper acts as a check valve to prevent reverse flow. Both damper curtains use a common grill and provide maximum control for the blowers.

Heacon Dampers are the answer to many flow control problems. Your problem may be a unique one that can be easily solved by our designs. Why not contact our representatives and let them help you with the solution to your control problem.

FIELD PROJECT ENGINEERS

ATLANTA, GEORGIA
C. E. Johnson & Associate
Bona Allen Building

BOSTON 10, MASS.
Thermix Engineering Co.
88 Broad Street—Room 610

BUFFALO, NEW YORK
Johnston Engineering Co.
1200 Niagara Street

CHARLOTTE 2, N. C.
T. C. Heyward
1408 Independence Bldg.

CHATTANOOGA 2, TENN.
Edgar A. Rogers
Chattanooga Bank Bldg.

CHICAGO 6, ILLINOIS
Cochrane Engineering Corp.
309 West Jackson Boulevard

CINCINNATI 2, OHIO
Elman Equipment Co.
1101 Fed. Reserve Bank Bldg.

CLEVELAND 15, OHIO
H. W. Kaiser Company
1836 Euclid Avenue

DETROIT 2, MICHIGAN
Metrol Company
5538 Cass Avenue

HOUSTON, TEXAS
J. A. Rossiter Company
P. O. Box 1095

KANSAS CITY, MISSOURI
F. W. Hay & Company
2734 Cherry Street

LOS ANGELES, CALIF.
A. W. Anderson
164 So. Central Avenue

MINNEAPOLIS 2, MINN.
Hoyt A. Sevey
314 South 9th Street

MONTREAL 25, CANADA
T. C. Chown, Ltd.
1440 St. Catherine St., West

NEW HAVEN 5, CONN.
Daniel Smerling
P. O. Box 1169

NEW ORLEANS, LA.
Arthur C. Hays
1221-23 Carondelet Bldg.

NEW YORK 7, N. Y.
Parry Engineering Co.
154 Nassau St.

PHILADELPHIA 3, PA.
Thermix Engineering Co.
1003 Broad St. Station Bldg.

PITTSBURGH 19, PA.
Herr-Harris Company
545 William Penn Way

PORTLAND 4, OREGON
Lee & Freeman, Inc.
Room 302, Governor Bldg.
408 S. W. 2nd Avenue

RICHMOND 1, VA.
Frank Howell Company
Room 412, American Bldg.

ROCHESTER 4, N. Y.
Johnston Engineering Co.
31 Gibbs Street

ST. LOUIS 8, MISSOURI
Economy Equipment Co.
4526 Olive Street

SALT LAKE CITY 9, UTAH
The Lang Company
267 West First South
P. O. Box 479

SAN FRANCISCO 4, CALIF.
S. Herbert Lanyon
58 Sutter Street

SCHENECTADY 8, N. Y.
D. R. Whipple
6 Morris Avenue

SEATTLE 4, WASH.
Lee & Freeman, Inc.
1550 First Ave., South

WASHINGTON 11, D. C.
T. W. McGuire Company
137 Kennedy Street, N.W.

HEACON

THE THERMIX CORPORATION

Project & Sales Engineers

FIRST NATIONAL BANK BLDG. GREENWICH, CONNECTICUT

Accurately made to close tolerances
Uniform rib width
Ample lap widths
No cracks on outside corners
No wrinkles on inside corners

No Wrinkles... No Cracks... No Blowouts!

no place for leaks in THIS heat exchanger gasket

TAKE A CLOSE LOOK at the Goetze heat exchanger gasket shown above. Note the absence of cracks on outside corners . . . of wrinkles on inside corners . . . the uniform width of the ribs . . . the generous overlap of the metal jacket.

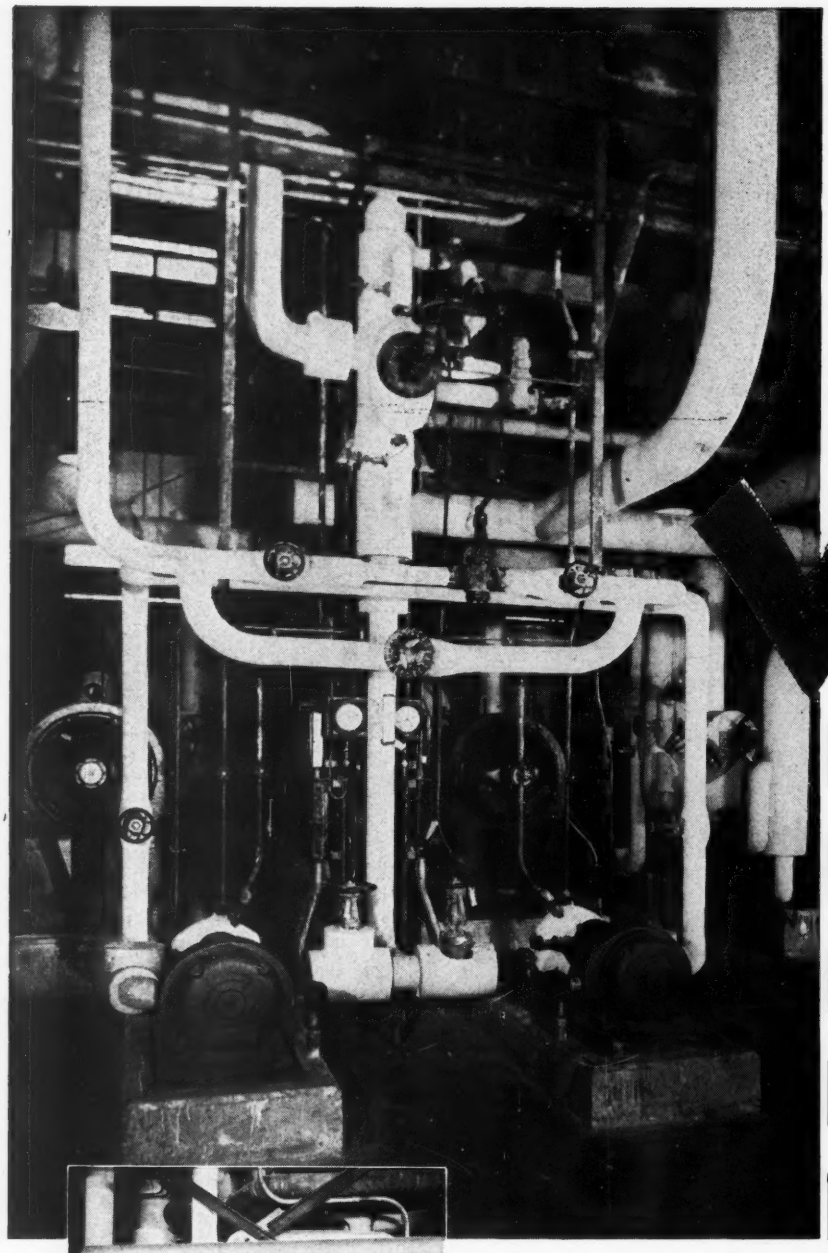
Attention to such important details is typical of the kind of care that goes into the forming of these custom-made gaskets. It is the secret of their dependable service—why you can count on them to stay on the job indefinitely without leaks or blowouts. And it's the reason they pay off in terms of less down-time and in the savings that result when gaskets *don't* have to be replaced at frequent intervals.

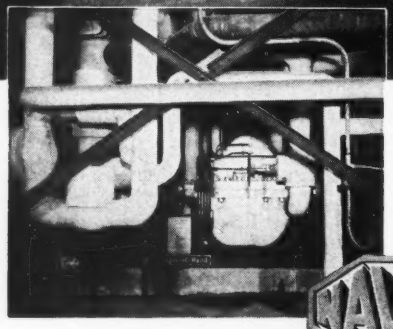
• • •

You can have Goetze heat exchanger gaskets made in any size or shape. Estimates and recommendations will be furnished promptly on request. Write Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville *Goetze* Gaskets





NAVCO PIPING INSTALLATIONS ARE THOROUGH

The measure of any piping system, after the proper design has been reached, is the "fit." The knowledge which we have gained in the past 40 years is your guarantee of an accurate and workmanlike piping system. Navco quality in workmanship and design is evidenced by the many successfully operating installations which we have made for every industry. Consult Navco for your next piping job.

NAVCO PIPING

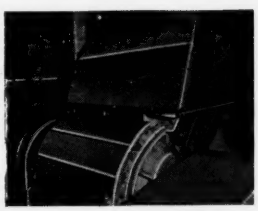
NATIONAL VALVE & MANUFACTURING COMPANY • PITTSBURGH, PA.

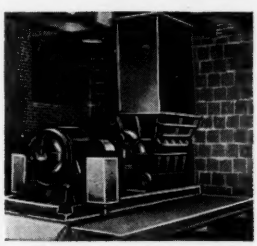
NEW YORK • CHICAGO • CLEVELAND • BOSTON • ATLANTA • TULSA • BUFFALO • CINCINNATI

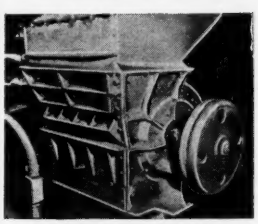
YOUR FIRST STEP toward GREATER COMBUSTION EFFICIENCY . . .

AMERICAN *Rolling Ring* CRUSHERS

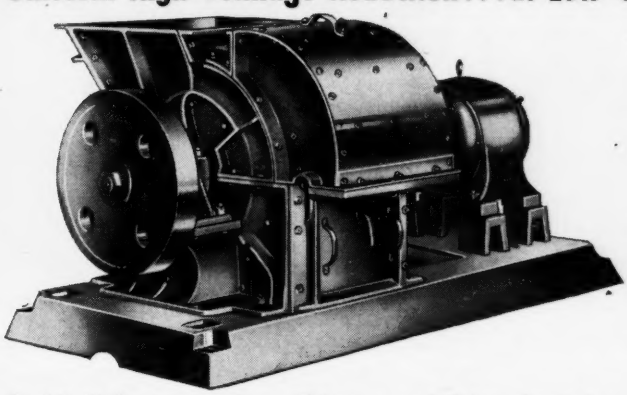
Uniform *High* Tonnage Reduction...at *Low* Operating Cost!







Custom-built for power plants, American Type "S" Crushers offer 9 different sizes, with capacities from 25 to 500 TP H.



COAL IS SPLIT - NOT CRUSHED

American Type "S" Rolling Ring Crusher, with heavy cast steel housing and sectional construction, secured at dust-tight, machined joints with coupling bolts for easy access to crushing chamber.

To hit highest operating efficiency, coal firing depends upon uniform sizing . . . one reason it pays to include American Crushers in your expansion and change-over plans. The exclusive shredder ring action of Americans—*through splitting instead of crushing coal*—gives a dependable uniform product with controlled fines—assure a loose, uniform firebed quickly responsive to sudden steam demands . . . without excessive ashpit drop or unnecessary CO2.

The minimum headroom requirements and independence from auxiliary crushing permit easy, economical installation of American without extensive alterations. Heavy cast steel housing and manganese steel shredder rings assure long, trouble-free service.

Send for your copy of "Crushing Coal for Less than 1¢ per ton."

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1429 MACKLIND AVE.
ST. LOUIS 10, MO.

* *"Boiler Water Treatment? What's That?"*

THIS EGYPTIAN FERRYMAN doesn't need boiler water treatment. There's no boiler scale on his biceps . . . no equipment to corrode . . . and as for carryover, he gets paid for that. • But these problems can be serious in plants powered by steam instead of sinews, or where water is used for process or cooling. That's why so many engineers depend on Bird-Archer's 8-Point Water Treatment Service. Backed by a half-century of experience, Bird-Archer has developed methods that effectively combat scale, corrosion and carryover . . . methods that keep operating costs DOWN and equipment efficiency UP. • For a profitable discussion of your water treatment problems, ask to have a Bird-Archer Field Engineer pay you a visit. There's no obligation.

LABORATORIES · ENGINEERS · CHEMISTS

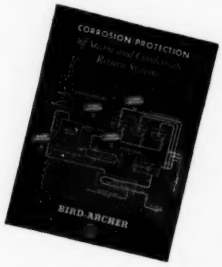
BIRD·ARCHER

THE BIRD-ARCHER COMPANY, 400 MADISON AVE., NEW YORK 17, N. Y.

Philadelphia, Pennsylvania • Chicago, Illinois • Montreal, Canada

CALDERAS Y ACCESORIOS, S. A. AMSTERDAM 291, MEXICO, D. F.

NEW BULLETIN

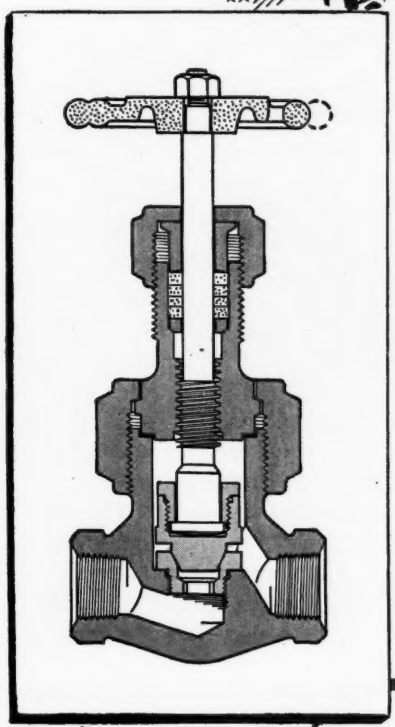


CORROSION PROTECTION OF STEAM CONDENSATE RETURN SYSTEMS

Just off the press, this informative bulletin outlines the Bird-Archer method of amine treatment. Write for your free copy today.

"We need 300# Globe Valves that we can install and forget..."

"Okeh... specify VOGT Series 3430"*



Sturdy drop forged steel valves like these won't let you down. They stay in there pitching year after year on your really tough jobs. Series 3430 valves have drop forged steel bodies and bonnets, 11½-13% chrome stainless steel seats and cone type loose discs. A flat gasket seals the male and female bonnet joint. The stuffing box can be repacked under pressure when the valve is fully open. These valves are also available with 18-8 stainless steel trimmings.

***Series 3430**

CARBON STEEL { 300 Pounds @ 750° F.
600 Pounds Cold Non-Shock

For 150-300 pounds general service Union Bonnet • Gasket Joint • Inside Screw Stem • Renewable Seat • 11½-13% Chrome Stainless Steel Trimmings Sizes ¼" to 2" inclusive.

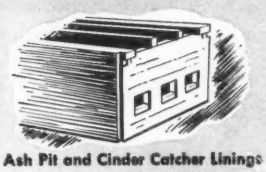
HENRY VOGT MACHINE CO.
Louisville 10, Ky.

BRANCH OFFICES: NEW YORK • PHILADELPHIA
CLEVELAND • CHICAGO • ST. LOUIS • DALLAS

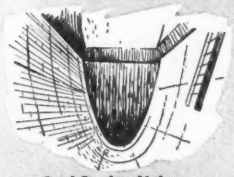
Vogt DROP FORGED STEEL VALVES

WHERE TO USE LUMNITE IN POWER PLANTS

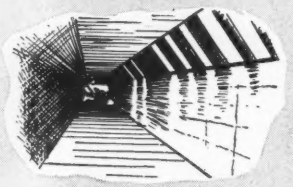
Steel Stack Linings



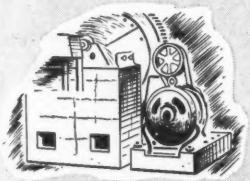
Ash Pit and Cinder Catcher Linings



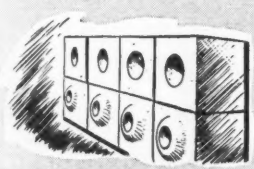
Coal Bunker Linings



Flue and Duct Linings



Overnight Structural Concrete



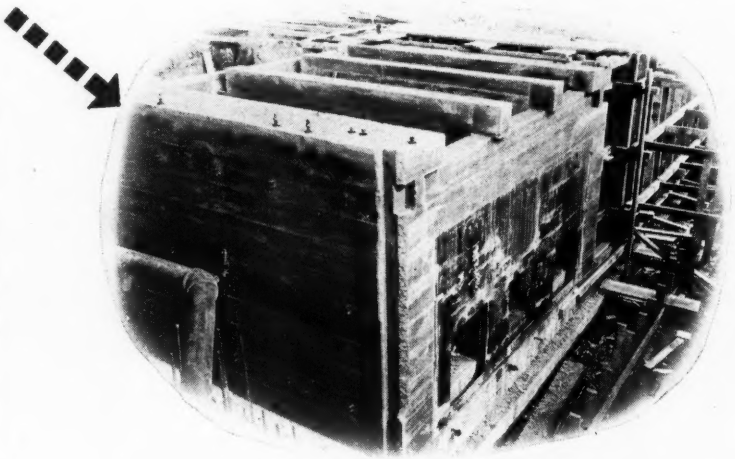
Castable Refractories

Factory-prepared mixtures of LUMNITE and selected aggregates. Mixed with water on the job, cast into place for door linings, arches, baffles, furnace walls. Special shapes can be cast in molds, ready within 24 hours. Castables to meet different temperature and insulation needs are made by manufacturers of Refractories, sold by their distributors.

Tough *LUMNITE Concrete

WITHSTANDS HEAT... CORROSION...WEAR

in self-lined Ash Pit



This combination boiler foundation and self-lined ash pit, built with heat-resistant LUMNITE concrete, is protected against soaking furnace temperatures, corrosion and wear from ashes and cinders.

Monolithic-concrete construction provides smooth surfaces with no joints to wear ragged and tear out. No refractory lining is needed with concrete made of LUMNITE calcium-aluminate cement and crushed fire brick aggregate. Such concrete remains sound and strong under continuous soaking heat from the boiler—it withstands temperatures well above 2000°F.

You also get fast construction with LUMNITE, the rapid hardening cement. Outage time is reduced to a minimum because LUMNITE concrete reaches service strength in 24 hours or less.

In ash pits, cinder catchers, and other power plant installations, as listed in column at left, LUMNITE combines high-early structural strength, high heat- and corrosion-resistance. Lumnite concrete also provides low thermal conductivity when insulating aggregates are used. Send for further information.

**"LUMNITE" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

PG-L-13

Lumnite Division

UNIVERSAL ATLAS CEMENT COMPANY

UNITED STATES STEEL CORPORATION SUBSIDIARY

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An $8,500,000,000 Investment

BY ROBERT H. SELLTITZ

Electrically minded Americans have nged the nation's electricity makers into biggest power expansion program the d has ever seen.

umbnail measures of its magnitude: to U. S. power making facilities ar 1939 are by themselves greater mbined generating capacity of Great Britain. New capacity completed in the next three es as much as has been tricity was discovered. rdstick: The $8.5 ty-making com- spend on ex- period is penditure rogram. spent over Vorld

he

The Wall Street Journal, February 21, 1949

10%

The power generating facilities designed and constructed by Stone & Webster Engineering Corporation through the years total over 6,000,000 kilowatts, equivalent to one-tenth of the total generating capacity of all electrical utilities in the United States.

Work of the Corporation currently in progress for leaders in the industrial and public utilities field in all parts of the country will increase this total over 2,000,000 kilowatts.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

WATERSIDE

(Continued from page 66)

HS No. 10 Double Inlet, Double Width and operate at 1182 rpm.

Two induced draft fans are provided per boiler. Each fan is a B.F. Sturtevant, Double Inlet, Double Width, Design 3 Turbovane, Size 1012 with erosion resistant wheel.

All fan and fan motor bearings are equipped with an alarm element embedded in the bearing babbit to indicate high bearing temperatures. The alarm is sounded on an alarm panel in the control room indicating the individual hot bearing, and after the alarm, the operator can, by using an indicator, determine the bearing temperature.

Each boiler is equipped with two Research Corporation electrostatic precipitators, each 3 sections long and 33 ducts wide, designed to remove 95 per cent of the entrained dust when handling 460,000 cfm of gas at 300 F. They are horizontal flow, steel plate type and are equipped with 12 pneumatic vibrators, timer controlled to vibrate the plates in a predetermined sequence for a few seconds of each hour to remove the collected dust. The duration of vibration, the frequency and sequence are all adjustable within limits.

The dust collected in the precipitator hoppers and other points of lodgement in the boiler, flues and stack is handled pneumatically and discharged into existing ash silos on the dock. The ash machinery is located in an existing machinery room, also housing the Waterside No. 2 ash handling machinery which was relocated to accommodate the new equipment.

Two complete sets of ash equipment were provided, each consisting of receiver, bag filter, vacuum pump, vacuum pump drive and water separator, with switching valves so that either may be used. A single ash header from the station to the dock was provided.

Like the existing Waterside No. 2 ash handling system, the receiver and bag filter of each set are arranged to discharge through a swing gate housing equipped with automatically controlled gates to discharge to either of two silos. Thus the high carbon content fly ash from flues and stack is segregated from the lower carbon ash from the precipitators, and stored in separate silos.

Control of the vacuum pump motors located in the machinery room is by push button from an ash control panel located in the station. The system is arranged to operate either through manual control or automatic sequence, whereby the change from one loading point to another in the system is controlled by change in pressure in the system. From the ash silos, the stored ash is discharged through existing rotary conditioners to render it dustless.

Below the tap hole in each furnace are a pair of slag rakes to remove the slag from the slag pit. These rakes were developed by the Company and have been used successfully on other installations. They are relatively inexpensive to install, have low maintenance and high availability and require very little attendance. Power consumption is very low as each rake makes only 3 or 6 strokes per minute, and is driven by a two speed 1-½-3 hp motor through a Universal gear.

In the slag throat, between the tap hole and the slag pits, a leaf damper is installed to direct the flow of slag to either of the two pits. Pit bottoms are inclined 20 deg to the horizontal.

Water nozzles in the slag throat spray and disintegrate the slag with cold water. Mounted over each pit is a motor driven slag rake, having several fixed flights of steel plate. The motion of the rake is alternately backward (upward) or forward (downward). On the forward motion, the rake is lifted above the slag and moved forward to the lowest part of the pit. As the forward motion ceases, the rake is lowered into the slag and the backward motion starts. Slag is raked up to

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Goodall Rubber Expansion Joints are based on a new simplified principle of operation and a patented construction which makes its application possible. All motion resulting from expansion, contraction and vibration takes place in center corrugation, size of which is determined by maximum movement required. Used on lines carrying fluids, steam, air, gases, under vacuum or pressure, at temperatures up to 250° F.

For All Standard Pipe Sizes From 3/8" to 96" I.D.

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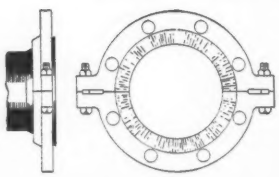

Goodall Expansion Joints have ends shaped to accommodate "Flang-Lok" Flanges. These are designed to simplify installation and to provide a positive nonmetallic seal by drawing the rubber or neoprene covered ends of the expansion units together. Furnished in steel or cast iron. Bolt holes are easily aligned by turning flange only. Magnitude of forces making seal is in direct proportion to stress applied to bolts when tightening.

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Having successfully accomplished the means of "cutting to the bone" ineffective areas, bypassing, eddies and excessive pressure drops, Ross now provides in the various sizes comprising the "CP" Exchanger line, *a greater heat transfer surface in a smaller, more compact unit.*

. . . and backing up these noteworthy performance developments are new manufacturing techniques as applied to the customary Ross mass production system of standardized parts manufacture. Closest practicable clearances between tubes and baffle holes, baffles and shell, and bundle and shell—*absolutely vital to complete, fully effective use of heat transfer surface*—are consistently and uniformly produced by new, precision, mass quantity manufacturing methods.

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the 20 deg incline during the backward motion, after which the rake disengages and starts its forward motion, each successive motion bringing slag up the incline where at the top, it drops over an apron into a car. The cars are then carried by an electric hoist truck to the ash hoppers on the dock. These rakes are substantially as described in *Combustion* of August 1943, and in POWER PLANT ENGINEERING in September 1943, having undergone only changes tending toward the improvement of individual parts.

Combustion Control

The combustion control was furnished by Hagan Corp. and is arranged to regulate air flow, furnace draft and coal feed to maintain steam pressure. The system has been designed so that the operator may select and operate an automatic, semi-automatic, remote manual or local hand control as required. It functions to control the delivery of the forced and induced draft fans through vane control mounted on the fan inlets.

Bailey Meter Co. three element control (water-flow, steam-flow, water level) is provided to regulate the speed of one or more of the feedwater pump turbines as required by feedwater demands of the boiler. Water flow is balanced against steam flow and corrected for water level, resulting in an impulse which regulates the steam flow to the feed water pump turbines and controls pump speed. Water level is brought visually to the control board mechanically by a Yarway Level Indicator. Paralleling this indicator is a Diamond Power Specialty Co. Utiliscope, bringing the image of the level to the control board through the television principle of camera and image screen. Another image screen at the pump control board allows the pump operator to also see water level. A water level recorder is mounted on the vertical control panel.

The centralized boiler control consists of a bench board and a vertical panel. On the bench board are mounted the controls for mills, feeders, fans, steam temperature, feedwater and ignition signals together with the required position indicators. The central section of the bench board comprises the operator's desk and telephone facilities, with the individual boiler controls occupying either end section. The vertical control panel is in front of the bench board and is used for mounting of meters, gages and indicators upon which the operator relies for operating guidance. The central section of the panel is occupied by the high pressure turbogenerator load indicators, with the boiler instruments located adjacent toward either end. The far ends of the board are occupied by the low pressure steam and heater instruments for each unit. The bench board and vertical panel are constructed of 1 in. thick ply-wood panels covered both sides with light gray Formica, mounted on a structural steel framework. An alarm panel upon which is mounted temperature instruments and alarms as well as other miscellaneous panels are located in the control room and are of similar construction. All walls of the control room are covered with Formica panelling. In general, the bench board, vertical panels and alarm panels are similar in arrangement and construction to those used on previous installations and described in *Combustion* of March 1942 and August 1943, and in POWER PLANT ENGINEERING in September 1943.

The boiler feedwater is essentially condensate, but due to the fact that these stations supply steam to the New York Steam Corp., from which no condensate is returned, the make-up requirements are heavy. A water softening plant was installed in Waterside No. 2 in 1939, designed to treat the make-up requirements of that station. This system has now been expanded to a capacity of 2,400,000 lb per hour of mixed effluent to supply the needs of both stations. A 2,000,000 lb soft water head tank is located in 39th

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A laboratory controlled product blended to meet exacting stoker requirements. From Wise County, Va., on the Interstate Railroad.

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Genuine Pocahontas from McDowell County, W. Va., on the Norfolk & Western Railroad.

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Street between the two stations to act as a storage reservoir. It is arranged to float on the make-up line between the soft water pumps in Waterside No. 2 and the condensers of the low pressure turbines in Waterside No. 1.

In addition to pre-softening the water, provision has been made to treat chemically all feedwater entering the boilers as required to maintain proper boiler water conditions. For this purpose, three Milton Roy Co. Simplex pumps are installed to deliver sodium phosphate to the boiler drums and three Lapp Insulator Co. Simplex "Pulsofeeders" deliver sodium hydroxide to the deaerators. One phosphate and one hydroxide pump serve each boiler, with the third phosphate and hydroxide pump as a common spare.

The continuous blow-down system for these two boilers consists of a high pressure flash tank where 33 per cent of the blow-down water is flashed to the 200 psig station system and a low pressure flash tank which receives the drains from the high-pressure tank and flashes 17 per cent of this water to the 5 psig auxiliary exhaust system. The remaining blow-down, not flashed, is drained to waste.

The system is remotely controlled by push button operation from the control room arranged so that a motor operated valve at the inlet of the high-pressure tank will close in event of necessity. An interconnected free-discharge valve to waste maintains a small flow of water through the line to prevent water hammer. The system has a capacity of 150,000 lb per hour through a combination of orifices designed for various blow-down rates. The flash tanks were made by Babcock and Wilcox Co. and each tank is provided with a number of cyclone separators arranged to remove effectively the moisture from the flashed steam.

This installation embodies in the design the features and developments which will make these boilers the most trouble-free, easiest to operate and highest availability units to date on the Consolidated Edison System.

* * *

A new device, the Transductor, is, for one application, in effect a static direct current transformer. It is used for measuring direct currents of thousands of amperes flowing in a single bus. The device consists of a current transformer of the "through type" placed in the bus. The secondary winding is energized by low voltage alternating current. A change in direct current affects the reluctance of the transformer and in turn the current in the a.c. winding. The a.c. is measured in terms of the direct current in the bus.

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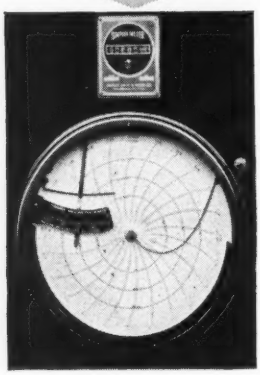

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COMING EVENTS

The Spring Meeting of the Prime Movers Committee, of the Pennsylvania Electric Association, will be held at the William Penn Hotel, Pittsburgh, May 5 and 6.

ISA—The Fourth Annual Spring Meeting of the Instrument Society of America will be held at the Royal York Hotel, Toronto, Canada, May 12 and 13.

NSSC—The National Steam Specialty Club Annual Meeting to be held at the Skytop Lodge, Skytop, Pennsylvania, May 18-20.

NDHA—The 40th Annual Meeting of the National District Heating Assn. will be held at The New Ocean House, Swampscott, Mass., May 24-27.

The Annual Wisconsin Power Conference and Exposition will be held at the Schroeder Hotel, Milwaukee, June 2, 3, and 4.

AIEE—1949 Meeting of the American Society of Electrical Engineers, Summer General Meeting, Swampscott, Mass., New Ocean House, June 20-24; Pacific General Meeting, San Francisco, Fairmont Hotel, August 23-26; Midwest General Meeting, Cincinnati, Netherland Plaza Hotel, October 17-21.

ASTM—The 52nd Annual Meeting of the American Society of Testing Materials to be held at the Chalfente-Haddon Hall, Atlantic City, June 27 to July 1.

ISA—The Fourth National Instrument Exhibit to be held at the St. Louis Municipal Auditorium, St. Louis, Sept. 12-16.

ASTM—The First National Meeting of the American Society of Testing Materials to be held on the West Coast will be held at the Fairmount Hotel, San Francisco, October 10-14.

ASCE—1949 Meeting of the American Society of Civil Engineers, Summer Convention, Mexico City, July 13-15; Fall Meeting, Washington, D. C. November 2-4.

Midwest Power Show—The 9th Midwest Engineering and Power Exposition will be held at Navy Pier, Chicago, November 11-16.

Obituaries

DR. WILLARD H. DOW

DR. WILLARD H. DOW, president of Dow Chemical Co., Midland, Mich. was killed on March 31, 1949 when a private airplane in which he was a passenger crashed and burned near London, Ontario. His wife, Martha Dow, who was accompanying him, also was killed in the accident, as was the pilot of the plane, A. J. Bowie, and another passenger, Mrs. Calvin Campbell. The latter's husband, Calvin Campbell, a fifth member of the party, was severely injured.

The party had taken off from the Tri-City airport near Midland, Mich. at 9:00 a.m. on March 31, planning to fly to Boston to attend a banquet at the Massachusetts Institute of Technology.

ALBERT CARROLL WOOD

CONSULTING ENGINEER, in Philadelphia, Pennsylvania, died March 13, 1949. He was born in 1874 in Fayetteville, Arkansas and was a graduate of the University of Arkansas. He received his degree of Doctor of Science from the University of Arkansas in 1943.

Mr. Wood came to Philadelphia in 1893 and became associated with Mr. J. J. De Kinder in the latter's engineering office. In 1902, he opened his own office and for the past 47 years, has been actively engaged in consulting engineering work in connection with the design and con-

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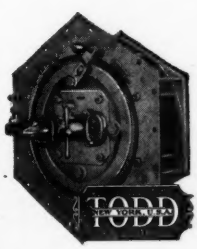

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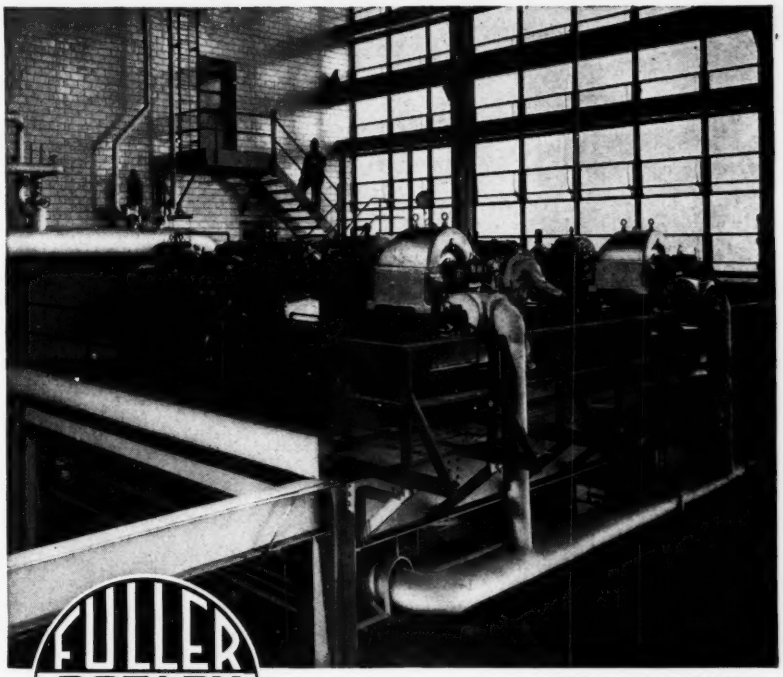

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in
SHERWIN-WILLIAMS
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Two Fuller Rotary Two-stage Compressors are installed in the new boiler house of The Sherwin-Williams Co., Chicago, shown above.

These compressors furnish air for both factory and power-house service. Each has a capacity of 1592 c.f.m., free-air, at 120-lb. pressure, driven by 350 hp. turbine, equipped with speed reducer, to operate at 575 r.p.m.

Fuller Rotaries are ideal units for any industrial plant. They are built in single and two-stage for capacities to 3300 c.f.m., actual free-air delivery, 125-lb. pressure; vacuums to 29.90-in. (referred to 30-in. barometer).

Bulletin C-5 illustrates and describes these machines. We will gladly send you a copy.

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struction of municipal electric light plants, and boiler houses and power plants for the paper, cement, textile and steel industries.

He was the author of many technical papers and held several patents. He often served as an expert witness in patent cases, as well as at Public Utility Commission hearings.

Mr. Wood was a Fellow in the American Society of Mechanical Engineers, and had served on the Power Test Code Committee of that Society. He was also a member of the American Institute of Electrical Engineers and the Society of Professional Engineers.

U. S. CIVIL SERVICE JOBS

THE U. S. CIVIL SERVICE COMMISSION has been accepting applications for several months for engineer positions; however, sufficient eligibles have not yet been obtained to fill existing vacancies. The Commission wishes to bring these examinations to the attention of qualified persons who have not yet applied. The jobs are located in various Federal agencies in Washington, D. C., and vicinity, and pay entrance salaries ranging from $2,974 to $5,905 a year.

No written test is required for any of the positions. To qualify, applicants must have had education or experience in engineering or a combination of such education and experience. For positions paying $3,397 and higher, professional engineering experience is also required. The maximum age limit for jobs at $2,974 is 35 years; for other jobs, 62 years. These age limits are waived for persons entitled to veteran preference.

Announcements and application forms may be obtained by interested persons from the U. S. Civil Service Commission, Washington 25, D. C. Applications for positions at $2,974 will be accepted in the Commission's Washington office until further notice; for the higher-paying positions, until June 30, 1949.

New ENGINEERING BOOKS

The Hiwassee Valley Projects, Technical Report No. 5, Volume 2; by the Tennessee Valley Authority; 785 pages, illustrated, 6 by 9 in., cloth binding. Available from Superintendent of Documents, Washington 25, D. C. Price $2.25.

This is the second of two volumes comprising the report, this volume covering planning, design, construction costs, and initial operations of the Apalachia, Ocoee No. 3, Nottely, and Chatuge projects in the Hiwassee Valley. Although they were constructed on an emergency basis during World War II, the development of the Hiwassee River was not a war time program but was integral with the unified development of the Tennessee River system and their construction was merely advanced in schedule by the requirements of the war.

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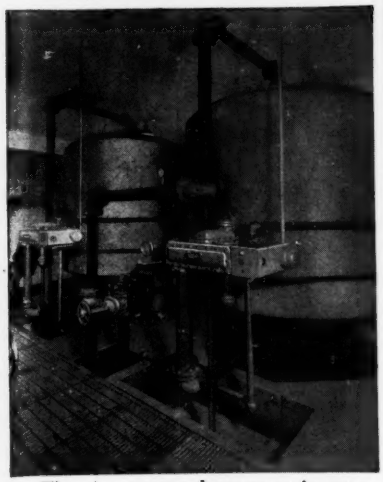

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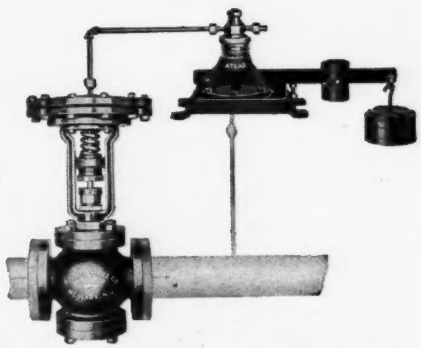

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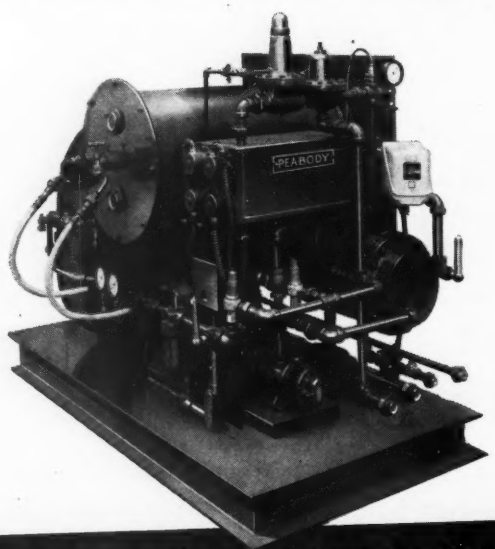

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investigations for the project, river flow, dam and power house design, access routes, construction methods including construction plants and river diversion, re-location and adjustments made necessary by creation of the reservoirs, initial operations, and a complete summary of the project costs.

The appendixes include complete statistical data on the physical features, reports of engineers and geologic consultants, and bibliographies. This is one of the series of reports on the entire Tennessee Valley Authority development of which previous volumes have been noted in these columns. These are the only comprehensive technical reports issued on the various features of the project.

• • •

Diesel Engineering Handbook; 1946-1947 Edition. Originally edited by L. H. Morrison; revised by Staff of Diesel Power and Diesel Transportation; 962 pages, illustrated, size 6 by 9 in., cloth binding. Published by Diesel Publications, Inc., 192 Lexington Avenue, New York 16, N. Y. Price $5.00 U.S., $6.00 elsewhere.

This is the sixth edition of a quite popular handbook dealing with the Diesel engine and its many applications. This edition comes at a time when the internal combustion engine is performing outstanding service in every form of power application. The principal revisions in this edition have been in style, mathematical presentation, and the inclusion of outstanding new developments in the engine itself, its accessories, and applications.

The book is descriptive and non-mathematical. Hence it seems most practical and useful for power engineers operating Diesels as well as for students of the Diesel engine, and teachers. It should also prove extremely useful to consulting engineers, for it contains many details of present-day engines not shown elsewhere.

The discussion covers principles of the engine, fuel-injection and combustion systems; efficiencies and economics; combustion of fuel; details of fuel-injection pumps and spray nozzles; mechanical details of frames, pistons, crankshafts, etc.; governing, supercharging, fuel handling, lubricating, cooling water systems; exhaust systems; starting systems; voltage regulators; couplings and clutches for Diesel drives. The handbook also contains advertisements of many manufacturers of Diesel engines and their accessories and auxiliaries.

The book contains many detailed discussions of installation and maintenance of various parts of the engines. It is a must for the Diesel engine man.

• • •

Principles and Methods of Telemetering, by Perry A. Borden and Gustave M. Thynell; 230 pages, 106 illustrations; size 6 by 9 in., cloth binding. Published by Reinhold Publishing Corp., 330 W. 42nd St., New York 18, N. Y. Price $4.50.

Recent increases in the diversity and magnitude of application of telemetering principles, according to the authors, has prompted several efforts to systematize the available information on the subject. The comprehensive attempt of the AIEE to coordinate the art of telemetering has been somewhat abstract and their treatment of basic principles has been restricted to types rather than to makes of equipment. Accordingly, the inquirers, under preliminary guidance of the Report, attempted to seek further information from the manufacturers whose equipment and methods appeared to be best suited to the problem in hand. The study by the authors has been sponsored by the Bristol Co. with the cooperation of leading manufacturers of equipment, to whom they went directly for data.

As a result the book discusses present-day methods and equipment as found in various modern installations. The principal emphasis of the book is on electrical methods of telemetering but there is one short chapter at the end discussing the principles and applications of fluid telemetering, using either air or hydraulic fluid for transmission of pressures as measures of the variable quantity.

The book opens with discussion of the fundamental principles of electric telemetering systems, discussing current or conductance, voltage systems, frequency systems, and position systems, using both dc and ac, also impulse systems. Examples of impulse telemetering systems are given; there is a discussion of interconnecting circuits and channels. Carrier current telemetering is described in some detail and there are chapters on coordinating, totalizing, computing, and integrating and on selection and application of telemetering systems. A detailed list of registered names and trade marks in this field and list of patents in allied fields appear at the end

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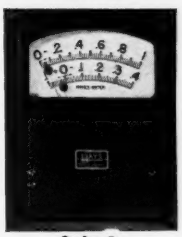
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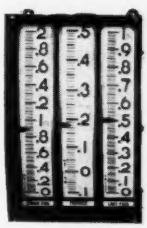
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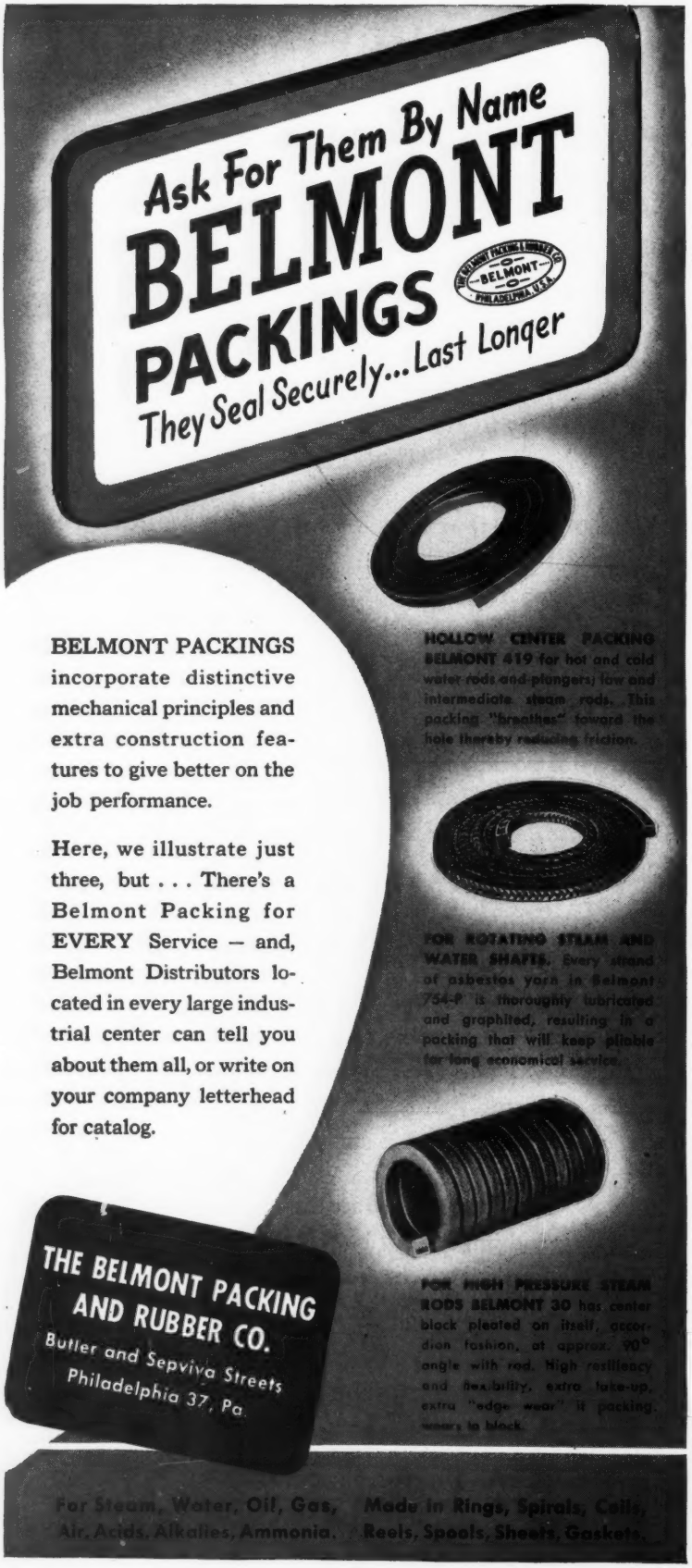
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of the book, and there is an extensive bibliography of the literature of this subject.

The book is extremely practical in its discussion of the operation and application of the various types of equipment, being entirely non-mathematical.

The use of fluid telemetering, especially in power plant work and in some types of industrial work, is somewhat more extensive than this book seems to indicate. But that can probably be accounted for by the fact that this development is much more recent, because of the development of certain new equipment and methods during the war, which are just beginning to come into the field. Practically every manufacturer of control equipment now has some type of pneumatic or hydraulic transmitter and manufacturers are developing them who have no other metering or control devices.

• • •

Manometer Tables, Tentative Recommended Practices, RP2.1, by Manometric Practices Sub-Committee, ISA; 32 pages; 8½ by 11 in.; paper bound; sponsored and published by Instrument Society of America, 1117 Wolfendale Street, Pittsburgh 12, Pa. Price $2.00 postpaid to non-members, free to members.

Coding of Thermocouple Wire and Extension Wire, Tentative Recommended Practices, RP1.1, by Sub-Committee on Thermocouple and Extension Wire, ISA; 4 pages; 8½ by 11 inches, published by Instrument Society of America, 1117 Wolfendale Street, Pittsburgh 12, Pa. Price $1.00 postpaid to non-members, free to members. (Checks in New York bank funds must accompany orders for the above, says ISA.)

The Manometer Tables present abbreviations and fundamental conversion factors commonly used in manometry, recommended definitions of pressure in terms of a column of mercury and water, and, for a large number of liquids, tables of pressures indicated by or equivalent to heights of columns at various temperatures.

These data are presented to facilitate and standardize the use of manometers and U-tubes as direct pressure-indicating instruments or in the calibration of pressure recorders and controllers.

Since manometers are widely used in power plant test work and routine power plant operation, we presented the detailed article on Using Manometers in the Power Plant by Tyler Hicks, in the December 1948 issue of POWER GENERATION. Readers of that article now using manometers, or wanting to learn how to use them for meter calibration and other purposes, will find the ISA Manometer Tables of great value in this work.

The publication on Coding of Thermocouple Wire and Extension Wire was prepared to bring about greater uniformity in the field of instrumentation. Tables give recommended symbols for thermocouple combinations and extension wire, as follows: Iron-Constantan (Types J and Y); Chromel-Alumel; Platinum, 10% Rhodium-Platinum; Platinum, 13% Rhodium-Platinum; and Copper-Constantan.

• • •

Q.E.D., M.I.T. in World War II, by John Burchard; 350 pages, illustrated; size 6 by 9½ in., cloth bound. Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $3.50.

Never isolated, even in peace, behind an ivory curtain, the Massachusetts Institute of Technology staff in war became involved and redistributed to a greater extent than that of almost any other American institution, as this volume bears detailed testimony. So says James R. Killian, Jr., now president of M.I.T., in the last chapter of this book, explaining how the Institute is reorganizing itself to meet postwar demands.

The purpose of this book, therefore, is to present the details of the participation of M.I.T., in the manifold scientific and engineering developments of World War II. The author attempts to bring out the quality of unity and of single-minded attitude it produced in all the Institute's war-time activities.

The value of doing this is partly historical, to get it on the records as a unified story; but much more important from the scientific and engineering point of view, to show the relations of the various activities from which it may be possible to learn some lessons.

The author, John Burchard, was in a singularly fortunate position to write about these activities. He has served as Director of Libraries at M.I.T. and, during the war, occupied important positions with the National Research Council and the Office of Scientific Research and Development, including two years in the

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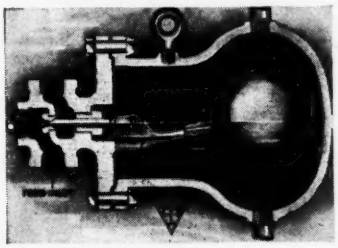

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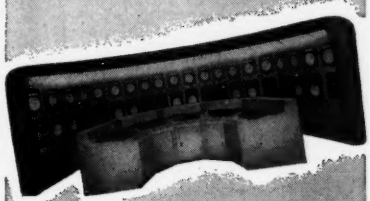

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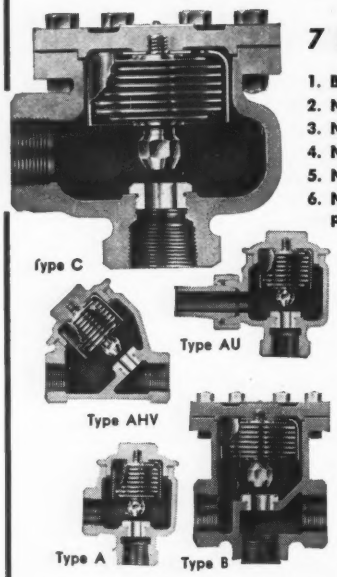

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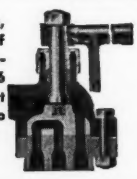

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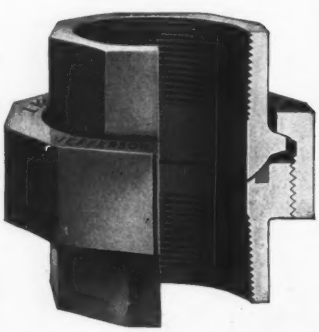

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Office of Field Service. To organize the complex war-time history of M.I.T. into a coherent story must have been a very difficult job. The result is a very valuable and interesting book. The war record of M.I.T. and the other great centers of war activity illustrates strikingly the power of co-operative group effort, and as such it is definitely worth reading.

The book begins with a discussion of M.I.T. in 1939, just before the war. In Part II, the author discusses research and development at the national level including the Research-Directing Agencies, the projects of the National Research Defense Council, projects carried on for Army, Navy and Office of Field Service.

Part III covers research and development; including such interesting items as the development of fire controls, the study of materials, flash photos and other tools, contributions of the Institute to the atomic energy project and, in particular, the important work done by the radiation laboratory.

Part IV discusses the functions of the Institute's staff absent on diverse missions; Part V, the home front: and Part VI is entitled M.I.T. Redeploys for Peace.

There is a glossary of code names and abbreviations, a personnel index, and a subject index.

* * *

Principles of Servomechanisms, by Gordon S. Brown and Donald P. Campbell; 400 pages, illustrated; size 6 by 9½ in., cloth binding. Published by John Wiley & Son, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $5.00.

As applications of control systems have increased in number, the demands imposed on their reliability, precision, and speed of operation have also increased. Fortunately, many of these demands have been satisfied because of developments in engineering and physics that have taken place simultaneously with the growth of automatic control. At the same time, the complexity of the mechanisms has often increased. As a result, the design of servomechanisms and automatic regulating systems has now become a science in itself.

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knowledge of the properties of the mechanisms of which they are composed. The book should, therefore, prove most valuable to the practicing engineer, who must understand the fundamentals of control systems, as well as to the designer, the engineering teacher, and the student.

The book begins by discussing the elements of control of which there are two general classes — the open-loop control, which is not treated here, and the closed-loop controls such as are encountered in the control of temperature, pressure, voltage, speed, position, and the like. Many systems are called servomechanisms—others are called regulators.

After explaining the elements and components, the book continues with a discussion of dynamics of elementary control systems; transient response; sinusoidal response of closed-loop systems; system diagrams, equivalent circuits, and block diagrams; introduction to synthesis, determining the gain K; methods of G function synthesis; linear coordinates and logarithmic coordinates; systems subjected to multiple disturbances; experimental studies in servomechanisms; methods for approximating the transient response from the frequency response. A table of sin $x \div x$ is included, together with problems on the various chapters, and there is a good bibliography and index.

Considerable mathematical knowledge is required for understanding the text and solving the problems.

Gas Tables — Thermodynamic Properties of Air, Products of Combustion, and Component Gases; Compressible Flow Functions (including those of Shapiro and Edelman); by Joseph H. Keenan and Joseph Kaye. 238 pages; size 7 by 10 in., cloth binding. Published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $5.50.

These **Gas Tables** supersede the previous book entitled **Thermodynamic Properties of Air** by Professors Keenan and Kaye. The properties of air have been reexamined and recalculated. The properties of combustion products of hydrocarbons and of the constituent gases have been added. Tables of functions useful in analyzing the flow of compressible fluids have been greatly extended.

The precision of the present tables is of the same order as that of modern steam tables, and the convenience is of a higher order for reasons explained by authors in the preface.

Need for a working table of the thermodynamic properties of air has been emphasized recently by the rapidly growing interest in the gas turbine. Computations of certain other processes, however — such as heating of air in a regenerator or expansion of air and similar gases from states of high temperature—involve laborious integrations of tabulated properties.

For example, in solving practical problems involving air and other gases, the examples given at the end of this book illustrate the use of the tables. Compression of air in steady flow can be easily calculated from the tables; also change in entropy; pressure in a turbine stage; polytropic expansions; compression of air and water vapor; adiabatic combustion at constant pressure, in which it is desired to find the flame temperature; adiabatic combustion at constant volume, when it is desired to find temperature and pressure after combustion; discharge of hydrogen from a closed container; and finally, the complete analysis of performance of a particular gas turbine—in all such problems, data from the tables are required.

In many cases, because of certain properties of the substance, tabulation is simpler than for vapors; therefore, a more detailed table is possible. Interpolation can often be dispensed with and, where necessary, only a single interpolation by inspection may be necessary.

In short, for anybody who must work either as a designer or as a practicing engineer in the field of air and gas compression and expansion and all the allied problems, this new book will be found as indispensable as are the steam tables for the steam engineer.

• • •

Report on Oil Engine Power Cost for 1947. 40 pages; size 8½ by 11 in.; paper binding. Published by The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, New York. Price $2.50.

This is the latest in the authoritative series of reports on oil engine power costs issued for a number of years by the ASME and compiled by the Subcommittee on Oil-Engine Power Cost, Oil and Gas Power Division, of which H. C. Major, Rockville Centre, Long Island, is chairman.

The purpose of these reports is fact-finding only and they do not attempt to establish conclusions or interpret the facts published. Certain of the data are plotted in chart form for illustrative purposes only.

This report presents information on performance and production costs of low-speed stationary generating plants only. It includes information from 117 oil-engine generating plants containing 396 engines, totaling 341,114 rated bhp. The total net output from these plants amounted to 600,886,727 kwhr.

Table I in the report gives detailed information on production costs for the plants reporting; Table II gives comparative costs from 1929 to 1947; and Table III shows engine details and operating information.

Although nine fewer plants reported than in 1926, the total installed hp and net kwhr output represent an increase of approximately 15 per cent. In view of the problems encountered in meeting the present unprecedented demand for power in the United States, the response of the operators in the reporting plants has been excellent.

• • •

Standards of Hydraulic Institute. Eighth Edition; 250 pages; illustrated; size 8½ by 11 in., loose leaf; paper bound. Published by the Hydraulic Institute, 90 West Street, New York 6, New York. Price $3.00.

The Hydraulic Institute is a trade association consisting of the principal manufacturers of displacement and centrifugal pumps in the United States. This eighth edition of its famous book of standards compiles the very latest technical and engineering data on pumps and piping, and should be in the hands of every designing and operating engineer who has anything to do with pumping equipment.

A standard of the Hydraulic Institute defines a product, material, process or procedure with reference to one or more of the following: Nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, quality, rating, testing, and service for which designed. Adoption of a standard by the Institute does not preclude any member or non-member from manufactur-

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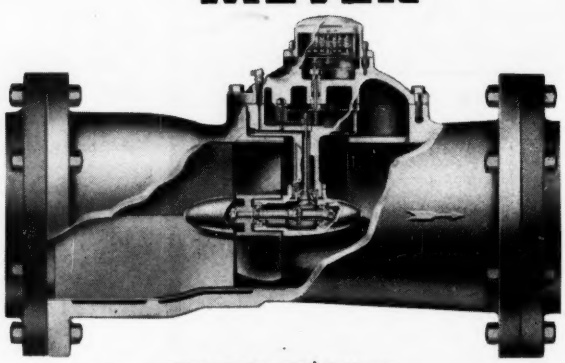

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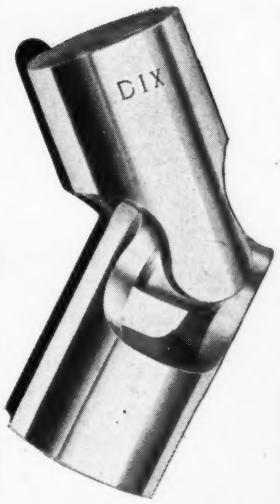

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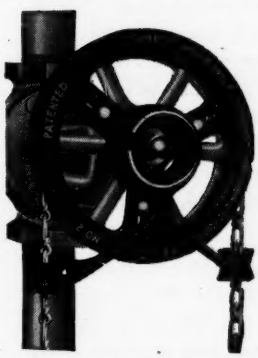

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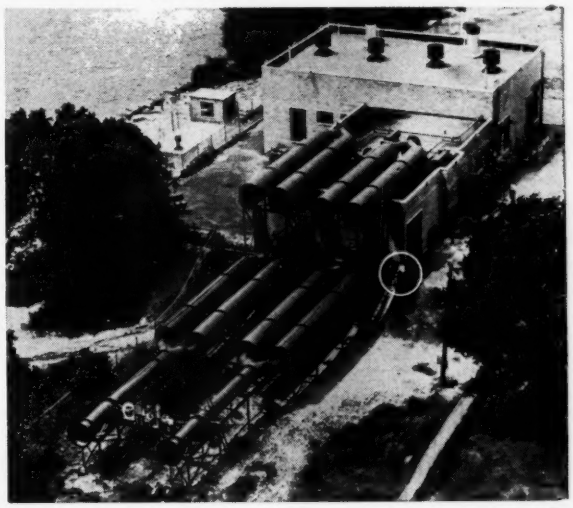

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The material in this book is submitted in what is being considered good engineering practice in the pump industry. It is divided into several sections, which may be removed if desired for convenience in handling.

The first section covers centrifugal pumps, including definitions of types and parts, curves of net positive suction head, instructions for installing centrifugal pumps, and many data on applications of pumps. This is followed by a complete test code for centrifugal pumps and the section ends with a detailed index.

The next section covers rotary pumps and follows in general the same organization. The pumps are described and defined; standards of volume, pressure, power, and efficiency are explained in detail; and instructions for installing and operating the pumps are given; followed, as before, by detail test code for rotary pumps and an index of the section.

The next section on reciprocating pumps in similarly organized; describing the pumps; giving curves of basic speeds; correction charts for temperature or viscosity, capacities and displacement of pumps; instructions for installation and operation; test code for power-driven reciprocating displacement pumps and direct acting pumps; and an index.

Next, comes a data section giving such things as friction of paper stock in cast-iron pipe; materials for pumping various liquids; and data required by pump manufacturers for proper selection of material.

The final and largest section in the book is on pipe friction; this gives tables of friction loss for water; data on old pipes; and charts of friction loss for any fluid, together with data on friction factors. Valves and fittings are described, with data on resistance to flow and how to calculate them. There are illustrated examples on using the tables for water, charts of friction losses, and data on construction of charts and tables to show various flow relations. There is a chapter on viscosity and detailed tables of friction losses for water, viscosity of common liquids, properties of steel and wrought iron pipe, and many other data.

• • •

Authority in TVA Land, by Dr. W. V. Howard. 185 pages; size 5½ by 8 in., paper binding. Published by Frank Glenn Publishing Co., 113 West 12th Street, Kansas City 6, Missouri. Price $2.50.

Here is a book that attempts to appraise TVA as it is today and show the public how a Regional or Valley Authority actually operates; which may differ widely from the way in which its supporters or opponents say it operates.

The writer states that he is a geologist by profession, residing at Dover, Tennessee; is president of the Dover Chamber of Commerce and of the Lower Cumberland Valley Association and is a director of the National Water Conservation Conference. He states he has received no assistance from any power or transportation company in writing this book: but, that it is based on his own observations, conservations with many people in various parts of TVA-land, and TVA's own reports which constitute a large majority of his references.

He discusses in turn such phases of the subject as "What is TVA"; "What is the Valley Area"; "Why was the Tennessee Chosen"; "What Has It Cost." He gives data on costs of navigation and flood control; on distribution of TVA power; on rural electrification. He goes into the details of TVA and its urban distributors; TVA as a realtor; and analyzes the propaganda, politics and popularity of TVA.

From all these data, for the source of which he gives suitable references, he comes to a conclusion summed up in the last paragraph of the book; viz, "To the America of today, the proper course of action seems to be to abolish the Authority, retain its contributions to the idea of regional development of water resources, turn its useful functions over to existing agencies and write the remainder off the books as a necessary cost of experience."

• • •

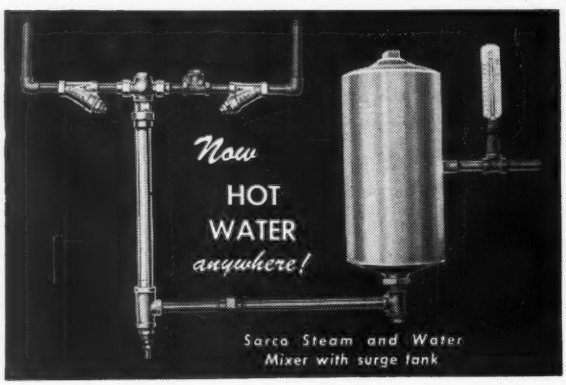
Differential Fluid Meters, by E. Curtis Richard. First Edition; 117 pages; illustrated; size 6 by 9 in.; cloth binding. Published by The Brown Instrument Co., Philadelphia 44, Pa. (Division of Minneapolis-Honeywell Regulator Co.) Price $2.00.

Contents of this book are published as the result of experience gained from twelve years of training and developing application and service engineers in The Brown Instrument Co. Service Training School. The author is a member of the Petroleum and Chemical Division of The Brown Instrument Co. The material is a condensation and development of materials used by instructors to give students, knowing little about the metering field, a firm basis on which to build. They were not intended to be exhaustive or cover the highly refined developments met with in application of meters to many industrial processes. The book should, on that account, be valuable in the general education program of industrial manufacturers, trade schools and colleges where courses on instrumentation are given. The discussion of meters is non-mathematical.

Section I covers principles of operation of the differential head flow meter, and Section II explains in detail primary measuring devices such as the Venturi tube, the Flow Nozzle, and the Orifice Plate. Many diagrams and details show how these devices are constructed, how they should be installed, and just how pressure taps should be connected.

Section III covers in detail secondary measuring devices, including those used by all the principle manufacturers of flow meters. Details of construction are given, tables of power requirements; data on low-differential meters; and tables of ranges and mercury requirements for various types.

Section IV is on telemetering, i.e., transmitting meter readings to a distance, giving details of the mechanisms given for this purpose. Section V explains in detail the Brown ratio controller for maintaining one variable at a predetermined ratio. Section VI describes integrators and their mechanisms; Section VII, interchangeable range tubes for Brown flow meters; and Section VIII is devoted to flow meter installation and operation, with instructions for locating meters, meter piping, and the like. Section IX covers preparing a flow meter for operation; and Section X, details of calibration.



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ENGINEERS' PREVIEW

REPORTS on DEMA's (Diesel Engine Mfrs. Assoc.) educational program by Ervin L. Dahlund, the Association's newly appointed director of education, were given at the recent annual meeting in Chicago. He gave the following as the six objectives of the program: (1) Well equipped laboratories for mechanical engineering schools, (2) planned use of this equipment, (3) improved texts, (4) better courses, (5) additional subjects for theses, and (6) the helping of professors to help themselves, through practical contacts in the industry.

Elaborating on the latter point, Mr. Dahlund said: "We are endeavoring to get the professors out of their schools and into the factories more and more, so that they will know what is expected of their students when they are graduated. These factory visits that DEMA arranges are more than just inspection trips—they are first-hand contacts with the Diesel industry's needs. The professors find out how many graduates per year a factory can take, what the graduates are expected to do, and what their opportunities are for advancement."

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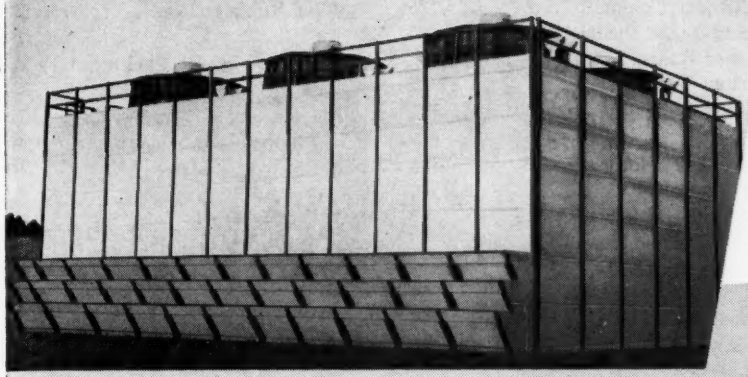

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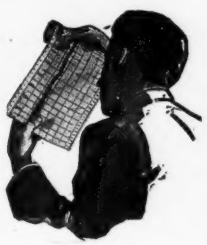

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Chapman List 960

. . . the forged steel gate valve that's

Built to Take it

Chapman was thinking of *your needs* when it designed this sturdy gate valve. That's why there are so many features that mean lower maintenance costs . . . longer years of useful life.

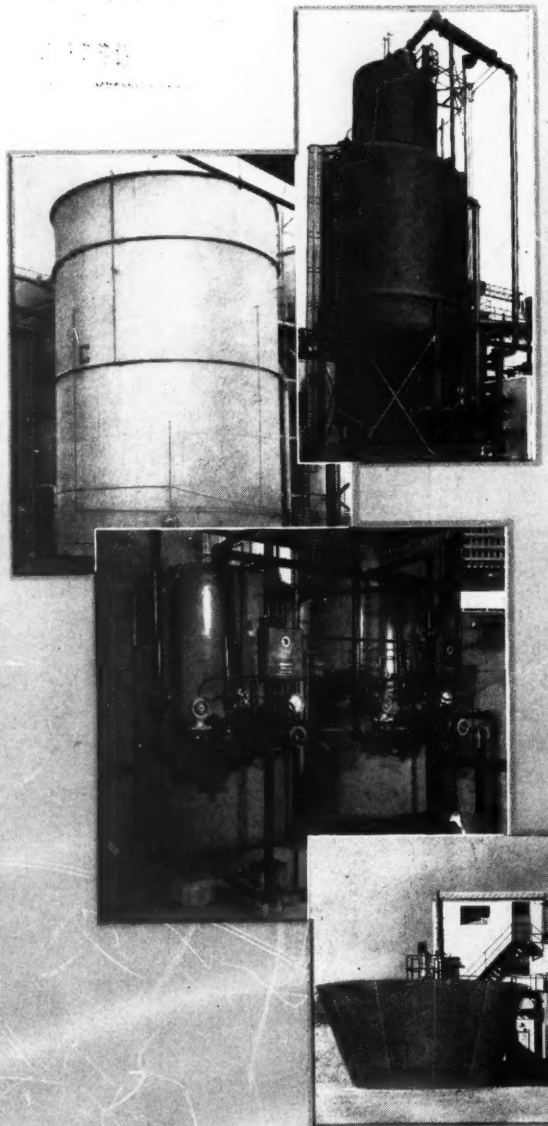
Take for instance the materials. There's tough forged steel in body and yoke . . . stainless steel in seat rings and plugs. Discs are not just hardened . . . they are superhardened by Malcomizing.

But that's only part of it. This valve is designed so you can repack it under full pressure . . . so that yoke threads are protected against rust and corrosion. And designed without gaskets to blow.

It's available in sizes from ¼" to 2" . . . carbon steel for pressures to 800 pounds; alloy steel for pressures to 1000 pounds at 750° F. For higher pressures, specify List 990.

The CHAPMAN Valve Mfg. Co.
INDIAN ORCHARD, MASS.

Water engineered to any requirement!



1. TO STOP CORROSION! Permutit's De-aerating heater prevents corrosion, removes all oxygen and free CO_2 from feedwater. Standard designs for pressure up to 100 psi and capacities up to 1,000,000 pounds per hour. Utilizes bled or exhaust steam.

2. TO ELIMINATE SILICA SCALE . . . by reducing the silica content with The Permutit Silica Removal Process! Reagents used are low-cost—do not add soluble byproducts. It can be adapted to existing equipment for hot or cold lime soda treatment or to Permutit Demineralizers.

3. TO SOFTEN WATER SUPPLIES! Permutit's Automatic Zeolite Water Softeners efficiently and economically remove hardness from water. The effluent is zero hardness water!

4. TO REMOVE IMPURITIES! Permutit's Precipitators remove turbidity, taste, color, odor, hardness, alkalinity, and other impurities from water supplies. Much less space, detention time and chemicals are required compared to conventional designs of reaction and settling tanks.

Write for full information on the equipment to The Permutit Company, Dept. PQ-5, 330 West 42nd St., New York 18, N. Y. or to the Permutit Company of Canada, Ltd., Montreal.

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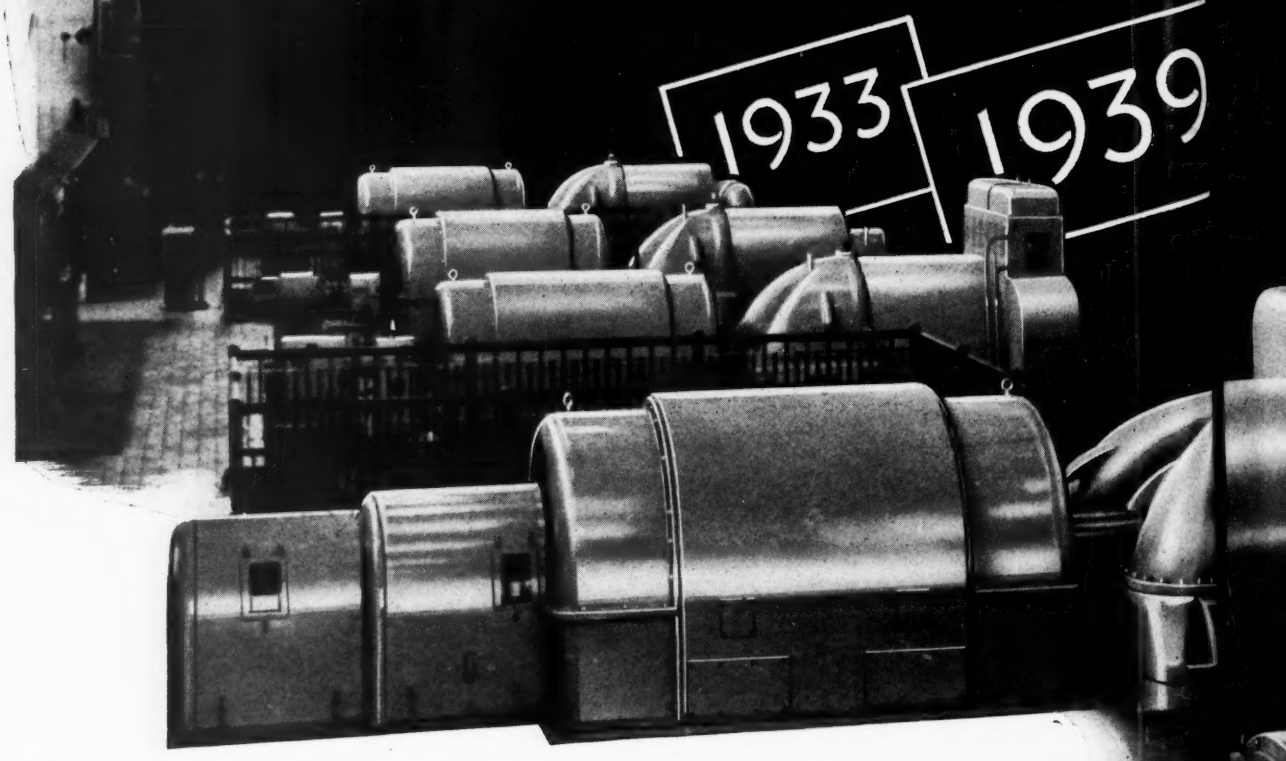
• • •

COVER: Two of four 12,500-kva., single-phase inert-gas auto-transformers, 138,000/92,000 v, at Nevada-California Electric Corp. (Allis-Chalmers photo)

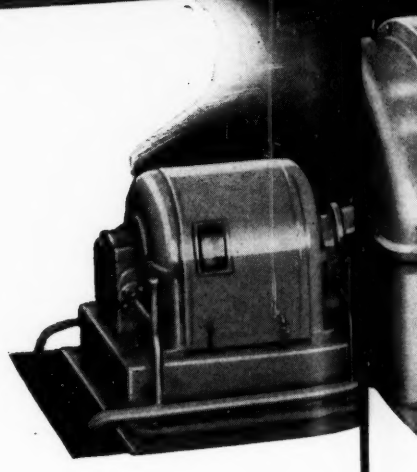
For Power Engineers Responsible for Supply of Steam, Electricity and All Other Power Plant Services

Because they keep on



CONFIDENCE like history, repeats itself — when it is soundly based. In this Ohio utility plant, the first two Elliott 4000-kw turbine-generators, installed in 1933, definitely made good. On the basis of their performance, another 4000-kw Elliott unit was installed in 1939. And now, in 1948, two more units are bringing the power output up to the 24-hour per day demands of a thriving and growing industrial community.

The latest installations are a 7500-kw unit, served by an Elliott condenser, and a 1000-kw noncondensing unit, which was installed to supply industrial process steam, or for use as a station house turbine. The entire installation is one of which any manufacturer could be proud.



For full details and descriptive bulletins, address

Elliott

epon making good

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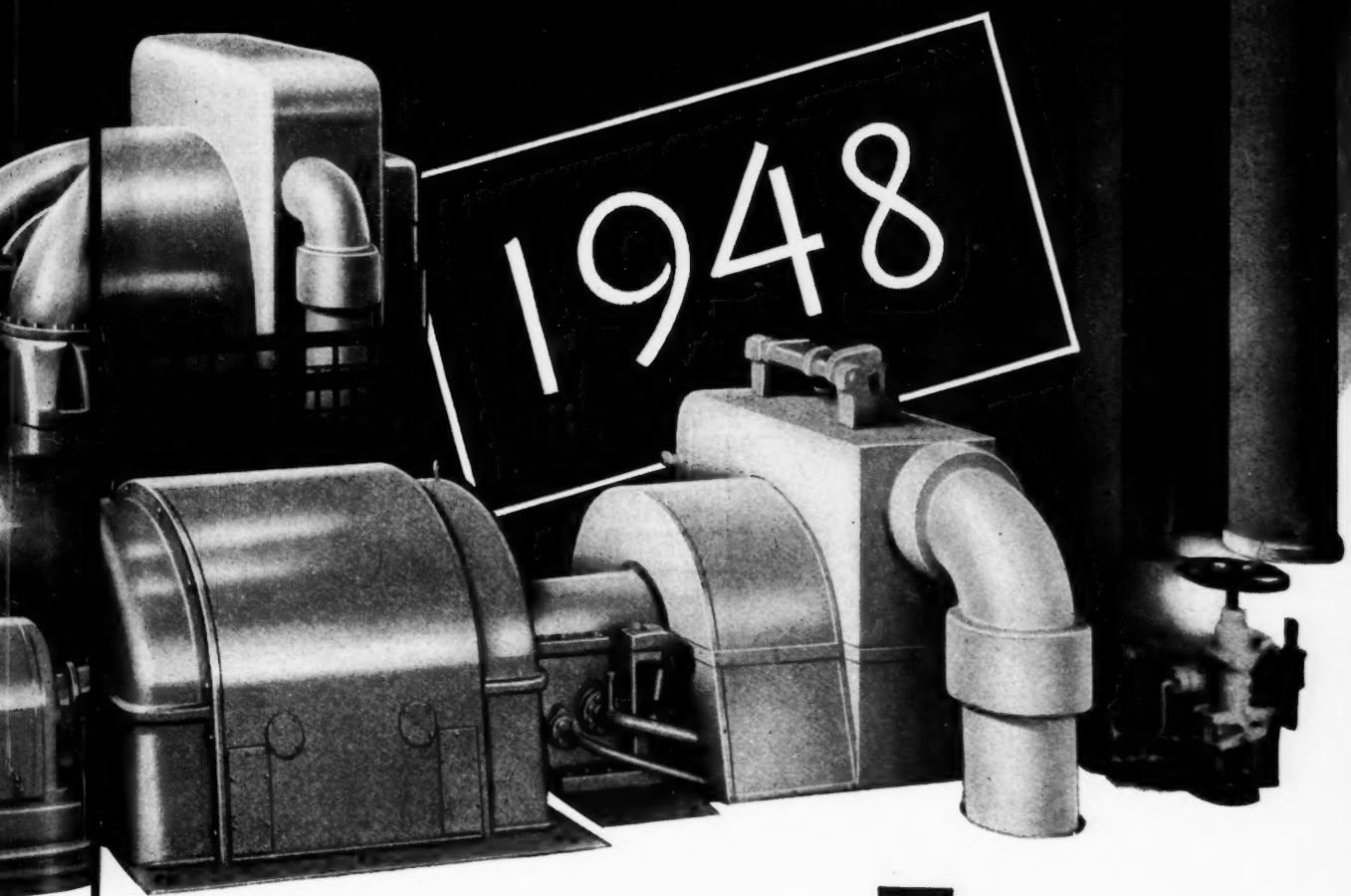

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on your gage, meter and instrument lines . . .
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EDWARD *FORGED STEEL* GAGE VALVES

YOU'LL FIND MANY ADVANTAGES in Edward forged steel gage valves over bar stock valves for instrument and meter lines, pump vents, Diesel and gas engines.

Here are eight important ones . . .

1. Forged steel bodies for extra strength.

2. Long taper semi-needle stem for close regulation.

3. Extra broad seat joint for tight seating.

4. Contoured T handle for easy operation.

5. Safety *taper* threaded joint prevents bonnet backing out of valve.

6. Hardened stem, lengthens life.

7. Bonnets and packing nuts EValized to reduce abrasion and corrosion.

8. Priced competitively with less strong "bar stock" valves.

Edward globe and angle gage valves are built in three metals—carbon steel; all parts 13% chrome stainless steel; or all parts 18-8 stainless steel, sizes ⅛"-1". Conservatively rated at 4000 lb at 150 deg, or 600 lb at 750 deg. Write for Catalog No. 103.

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